Atlas of Irish Groundfish Trawl Surveys

Supporting Fish Stock Assessment and New Ecosystem Advice

May 2012

Marine Institute
Foras na Mara

Fisheries Ecosystem Advisory Services
.. to research, assess and advise

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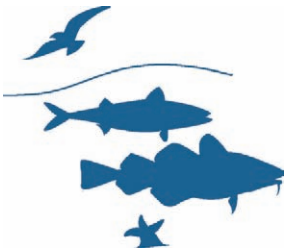

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Atlas series:
The atlas series of publications by the Marine Institute FEAS (Fisheries Ecosystem Advisory Services) focus on disseminating marine data in a visual and non technical format. The current "Atlas of Irish groundfish trawl surveys" is the 4th in the series. Previously published atlases are:

1. Commercial fisheries around Ireland (2009)
2. Atlas of demersal discarding (2011)
3. North Western Waters Atlas (2011)

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Aerial view of the Research Vessel Celtic Explorer.
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1 Introduction

Purpose of Atlas

The purpose of the Atlas is to communicate the key results from the Irish groundfish survey programme which is carried out annually in the waters around Ireland, and the Deepwater programme conducted between 2006 and 2009. The data are presented in a concise, visual and non technical format and provide an overview of the distribution and abundance of adult and juvenile fish species in Irish waters. The Atlas is aimed at those involved in fisheries, environmental policy and management, the fishing industry, environmental Non Government Organisations (NGO's), scientists and the general public.

The various groundfish surveys are described together with the gear used and the areas surveyed. A short note on the biology of each species is given together with their catch length profile and growth curve (size of 1 year olds; two year olds; etc.). The abundance and distribution of the main commercial and non commercial fish species caught on the surveys are mapped and a note on the distribution of the species in the wider Atlantic is given. The catches over time are plotted and a note of catch trends is given.

Two case studies are used to illustrate the application of survey data. The first focuses on Celtic Sea haddock and shows how the data are used to detect the scale of incoming haddock recruitment (juvenile fish), a critical input to the scientific assessment of the stock. The assessment forms the basis of the advice used by the EU to decide on the annual Total Allowable Catches (TAC's). The TAC is the main instrument used to manage fish stocks that come under the Common Fisheries Policy (CFP).

The second case study shows how the groundfish survey data can be used for the new ecosystem advice that is required by numerous international agreements and under new EU legislation (e.g. the Marine Strategy Framework Directive, MSFD). The MSFD requires member states to develop a marine strategy to protect and preserve the marine ecosystem and manage human activities (e.g. fishing) in a sustainable way. Two indicators are used to illustrate how data from the groundfish survey can be used examine the health of our marine ecosystem. The first is the "Conservation Status of Fish Indicator" (CSI), which can be used to evaluate the effects of fishing on the more vulnerable species within the fish community and the second is the "Large Fish Indicator" (LFI) which can be used to measure the size composition of individuals making up the community.

Scientific Groundfish Trawl Surveys

Fish stock assessments are the basis of the scientific advice that is used by fisheries managers to determine how many fish can be safely removed from the stock each year. Data collected from commercial fisheries are key inputs to the mathematical models used by scientists to conduct stock assessments (i.e. landings, hours fished – effort, fish length, weight, age, sex and maturity). These data are referred to as **fisheries dependant data.** As these data depend on the commercial landings composition, it can be biased by the behaviour of fishermen who can adapt their fishing behaviour, by moving to areas where fish are abundant and develop new fishing technologies in order to improve their catching efficiency.

In order to obtain a more independent data set from fish populations, scientific surveys are conducted. These surveys use standardized methods of data collection which provide consistent information that is used to build a "time series" of fish abundance. Survey data is referred to as **fisheries independent data**.

Groundfish surveys use standard nets to sample fish species found on or near the seabed, collectively referred to as "demersal fish or groundfish". The catch from the surveys gives a picture of what fish are on or just above the seabed in terms of the amount of any individual species as well as the proportions of one species relative to another. Trawling can be quite efficient for some fish, but unsuitable for others depending on the "catchability" of the gear. Therefore groundfish surveys do not provide an absolute estimate of abundance for all species.

Groundfish survey methods are rigidly standardised and conducted at the same time every year so that changes in catch abundance from year to year reflect changes in actual abundance on the seabed. As a result, scientific surveys can give an estimation of the relative abundance of species. In addition, scientific surveys provide important biological data on size and age distribution, maturity, sex ratios as well as spatial and temporal patterns of their distribution.

Scientific trawl surveys utilise nets of small mesh sizes which are suitable for catching juvenile fish. Therefore trawl surveys can provide an index of the proportion of juveniles in the stock before they appear in the commercial fishery. This is an important source of information not available from commercial landings due to the necessary minimum fish length restrictions on commercial catches and the larger mesh sizes used by commercial trawlers.

Although scientific fisheries surveys are usually targeted at commercially exploited fish species, data is collected on all caught fish including abundance and size distribution of non commercial species. This enables scientists to investigate and monitor the composition and the spatial and temporal changes of the entire demersal fish community.

With regards to spatial coverage, surveys provide data on species and environmental parameters in areas of both high and low commercial activities. This gives a better context to data for the entire survey area as opposed to focusing on traditional fishing "hot-spots" that can remain stable while significant changes in surrounding background abundance and distribution can occur.

International cooperation

Irish trawl surveys are part of regional survey programmes which are internationally coordinated through the International Council of the Exploration of the Sea (ICES). The **Irish groundfish survey (IGFS)** is coordinated within the International Bottom Trawl Survey Working Group (IBTS), which coordinates demersal shelf trawl surveys under ICES for the North Sea, Baltic and Northeast Atlantic. The **Irish deepwater survey (IDS)** is coordinated by the Working Group for Northeast Atlantic Continental Slope Surveys (WGNEACS). These ICES working groups are the forum where survey methodologies are standardised, data collection is coordinated in space and time and results are published in working group reports.

The Irish groundfish surveys are part of Ireland's international obligation to supply scientific data that support the implementation of the **Common Fisheries Policy (CFP)**. The **Data Collection Framework (DCF)** is the main instrument that is used by the European Commission to collect these datasets. The DCF is 50% funded by the member states and 50% funded by the Commission.

Structure of the Atlas

The atlas is divided into five sections. The first and second sections describe the rationale for the Irish groundfish survey and Irish deepwater survey, their survey strategies and sampling methodologies. It details the fishing gear used and how samples are collected and analysed to obtain the important indices of abundance.

Section three summarises the survey fish catch results in terms of species abundance and distribution, as well as the main trends in their abundance over time.

Section four, the main body of the atlas, provides a guide on how to interpret the maps and graphs of the most commercially and ecologically important species caught by the two surveys. Each species is summarised in terms of its survey distribution, biological attributes and temporal changes in abundance. There are 32 species described and these include the main demersal (groundfish), pelagic (i.e. midwater fish) and elasmobranch (i.e. sharks and relatives) species caught on the IGFS. The primary species caught on the deepwater survey are also covered in this section, including a selection of commercial and non commercial species as well as two deepwater shark species.

Section five focuses on the application of survey data to stock assessment and new ecosystem advice using two case studies. The first case study describes the use of survey data for Celtic Sea Haddock in a single species stock assessment. The second case study explains how data from groundfish surveys helps to provide information on fish communities and biodiversity. It highlights some of the ecosystem indicators that can be derived from these surveys and how these indicators can feed into newly emerging legislation which aims to incorporate ecosystem considerations into marine management.

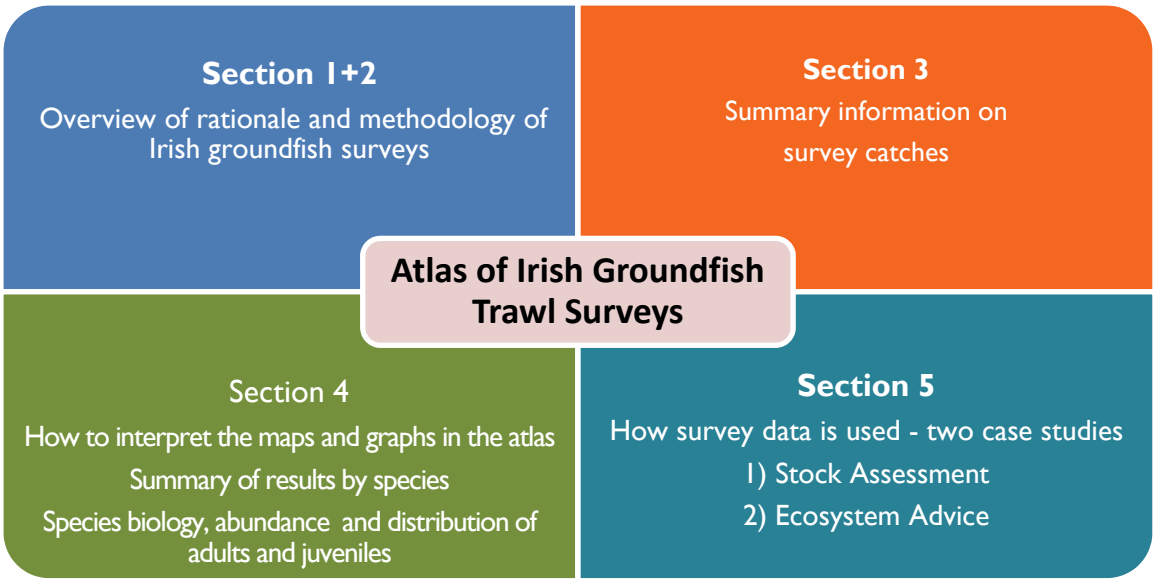


Figure 1.1 **Structure of the atlas of groundfish trawl surveys.**

The objective of this survey atlas is to show the biological information gathered on the Irish groundfish and deepwater trawl surveys and to illustrate how they are utilised in giving fisheries and ecosystem advice. The atlas displays distribution and abundance patterns of key commercial species as well as species of ecological importance with their size distribution and temporal changes in abundance.

2 Survey Methodology

Irish Groundfish Survey (IGFS)

The Marine Institute has conducted groundfish surveys to determine the distribution and abundance of commercial fish around Ireland since 1990. Historically, the surveys were carried out on commercial fishing vessels and later on small research ships (RV Lough Beltra). The Irish Groundfish Survey (IGFS) in its current form commenced in 2003 on the 65m research vessel, the R.V. *Celtic Explorer*. In the northwest it extends from the Donegal coast out to the shelf edge and also east to the coast of Scotland (ICES divisions VIa South). Off the Irish west coast it extends to the shelf edge (VIIb) and thereafter south into the Celtic Sea (Areas VIIg-j), see Figure 2.1. The survey is carried out annually with the northern area being undertaken in early October and southern and western areas being carried out in two legs during November - December.

The IGFS forms part of an internationally co-ordinated bottom trawl survey programme. For the waters around Ireland, France and Ireland cover the Celtic Sea area, Ireland cover the West of Ireland, Ireland and the UK cover the north coast of Ireland and the UK cover the Irish Sea.

The IGFS undertakes a total of 170 stations every year. Sampling locations are allocated using a "semi-random, depth stratified survey design". Stations are stratified according to ICES divisions and depth bands, resulting in the 17 strata which are shown in Figure 2.1. Haul allocation per strata is proportional to the area. Within each strata, 75% of the hauls are allocated from successful historic tows. The final 25% of hauls are based on information from the fishing industry and/or seabed mapping data from the Marine Institute's Advanced Mapping Program.

The stratification of IGFS has been periodically reviewed under ICES as a result of changes in survey activities around Irish waters. In 2003 and 2004 the IGFS included the Irish Sea (VIIa). However, from 2005 onwards the survey effort in VIIa was reallocated to new slope strata (200-600m) for VIa, VIIb and VIIj. This was in order to gather information on fisheries occurring on the shelf edge that were not previously surveyed. It also ensured sufficient overlap in international survey effort, while avoiding duplication of effort.

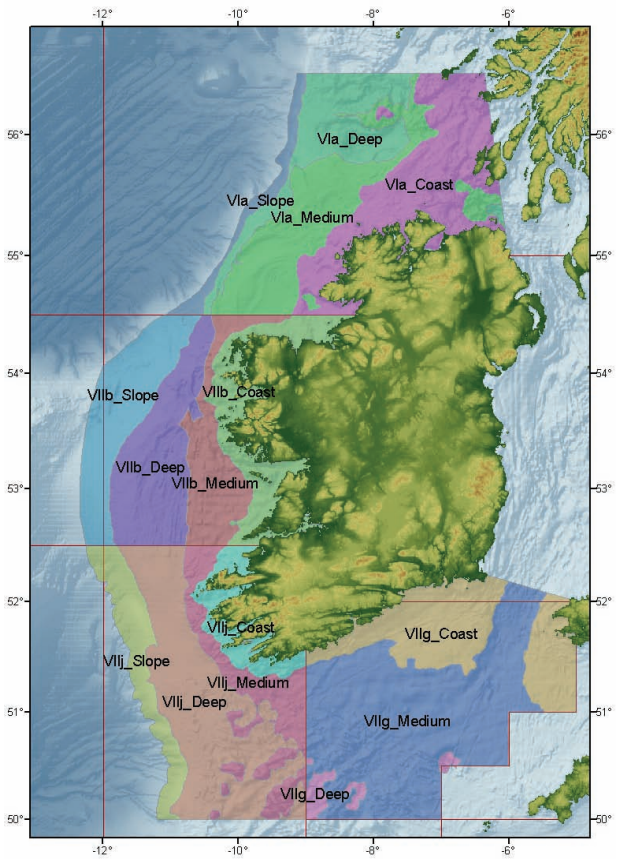


Figure 2.1 Map of IGFS strata.

Sampling Gear used on the IGFS

The survey trawl used on the IGFS is constructed in Ireland, but of French design. In order to sample species just off the seabed as well as those foraging upon it, a high headline "*Grand Overture Verticale"* (GOV 36/47) became a standard fishing gear amongst the countries that were IBTS participants. This allowed results to be easily compared across surveys over the wide area of the North Sea, where ICES and IBTS coordination originated. This coordination then expanded into the eastern Atlantic.

The GOV trawl normally maintains a headline height of 4.5m and is towed at a speed of 4 knots over the ground using otter boards (Morgere FP 10 doors). During fishing operation the trawl is continually monitored using real time trawl sensors giving details of wing-end spread, headline height, symmetry, trawl speed through the water, footrope touchdown, lift-off and door spread. In addition, the trawl is closely monitored on deck while hauling and shooting to ensure that the gear is fishing properly. See figure 2.2 for further details on demersal trawl gear.

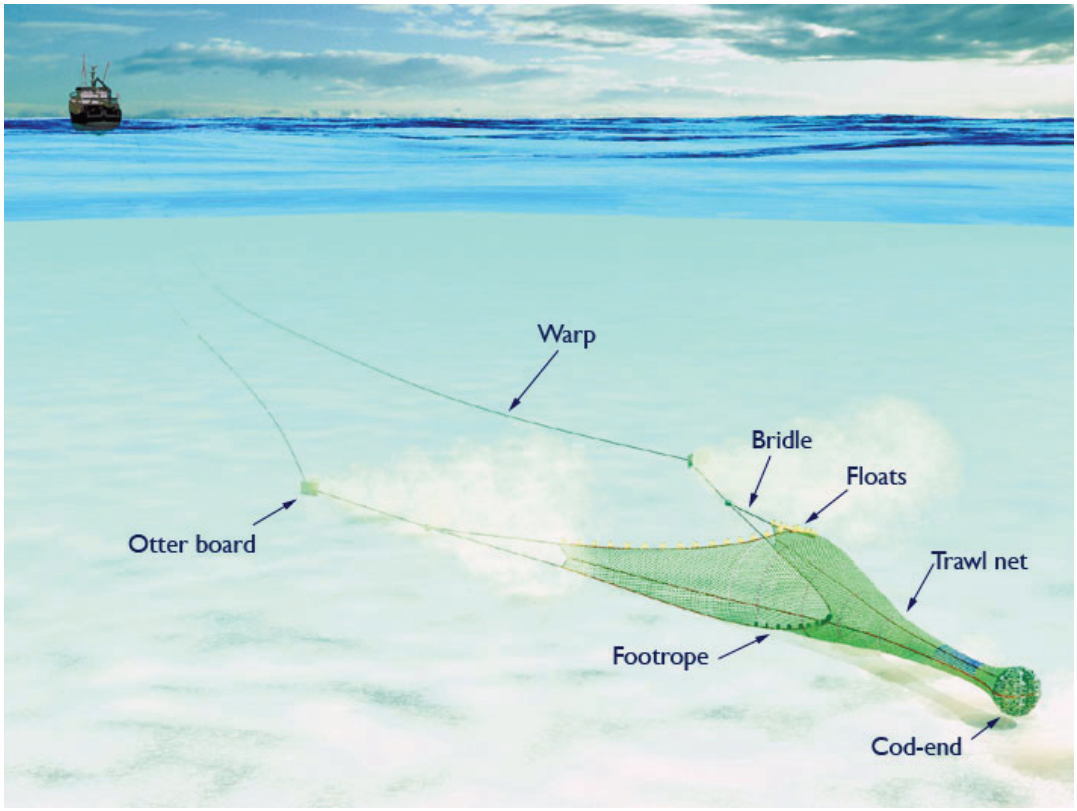


Figure 2.2 **Schematic diagram of the groundfish trawl gear used in the Irish groundfish surveys (Crown copyright, reproduced with the permission of Marine Scotland).**

Sample collection

Once the trawl is back on board the vessel, the catch is sorted into species in the fish room. As a key objective of the survey is to establish the proportion of juvenile to adult fish for each species (year class strength), it is important to get a good estimate of numbers at length. Often there is an abundance of the more common or average lengths so where it is not practical to measure all fish for a species, these more common lengths are sub-sampled and later re-scaled to produce an accurate length frequency. All fish, elasmobranchs, commercial cephalopods (squid, octopus and relatives) as well as some crustacenas are sampled and measured to produce a length frequency by species for each haul.

In addition, age and maturity data are acquired for the species listed in Table 2.1. All catch weight data are entered onsite into an Access database as catch sorting occurs. Data for each sample is then also entered in real time into the database via electronic measuring boards. All catch data for the day is later consolidated into a central survey database which also contains all other positional and gear parameter meta-data for the tows. For more details on the survey methodology and design see the IBTS western manual on: http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=74

In this Atlas, species catch rates are expressed as numbers of fish per hour trawled. Mean catch rates are calculated for the entire survey area by averaging across all valid stations, including hauls where the catch was zero for that species. Catch information is presented for two distinct areas (VIa and VIIbgj) for three reasons:

i) The northwest (VIa) region of the survey is particularly hard ground and therefore a more robust groundgear is used on the trawl throughout this area. Any differences between trawl design may affect sampling efficiency for some species between two areas.

ii) There is a time delay of approximately 5 weeks between completing VIa and commencing the remaining survey area and it cannot be assumed that fish are in a fixed area over that period of time and therefore catches can be directly compared.

iii) The two areas are geographically separate, with the northwest having inputs from North Sea stocks, while area VIIbgj is largely influenced by the Celtic Sea, Bay of Biscay and the probably the Porcupine Bank for some stocks.

Table 2.1 Species sampled for age and maturity on the IGFS (Y=Yes, N=No).

Common Name	Scientific Name	Aged	Maturity
Mackerel	*Scomber scombrus*	Y	Y
Allis shad	*Alosa alosa*	N	Y
Monkfish	*Lophius piscatorius*	Y	Y
Atlantic cod	*Gadus morhua*	Y	Y
Black-bellied Monkfish	*Lophius budegassa*	Y	Y
Blonde ray	*Raja brachyuran*	N	Y
Blue skate cf d batis	*Dipturus flossada*	N	Y
Blue whiting	*Micromesistius poutassou*	Y	Y
Brill	*Scophthalmus rhombus*	N	Y
Common ling	*Molva molva*	Y	Y
Common skate	*Dipturus batis*	N	Y
Cuckoo ray	*Leucoraja naevus*	N	Y
European conger eel	*Conger conger*	N	Y
European hake	*Merluccius merluccius*	Y	Y
European plaice	*Pleuronectes platessa*	Y	Y
European seabass	*Dicentrarchus labrax*	N	Y
Haddock	*Melanogrammus aeglefinus*	Y	Y
Herring	*Clupea harengus*	Y	Y
Horse-mackerel (scad)	*Trachurus trachurus*	Y	Y
John dory	*Zeus faber*	Y	Y
Lemon sole	*Microstomus kitt*	N	Y
Megrim	*Lepidorhombus whiffiagonis*	Y	Y
Pollack	*Pollachius pollachius*	N	Y
Red gurnard	*Aspitrigla (chelidonichthys) cuculus*	N	Y
Saithe	*Pollachius virens*	Y	Y
Black sole (dover sole)	*Solea solea*	Y	Y
Spotted ray	*Raja montagui*	N	Y
Spurdog	*Squalus acanthias*	Y	Y
Thornback ray (roker)	*Raja clavata*	N	Y
Turbot	*Scophthalmus maximus (psetta maxima)*	N	Y
Whiting	*Merlangius merlangus*	Y	Y
Witch	*Glyptocephalus cynoglossus*	N	Y

Irish Deepwater Survey (IDS)

The Irish deepwater survey was conducted between 2006 and 2009 and covered ICES areas VIa and VIIc. The aim of the survey was to produce abundance indices of shelf edge, slope and deepwater fish communities and collect biological information on the main deepwater species including length, weight, maturity, sex ratio and feeding.

The survey was carried out in three study areas along the continental slope of the northeast Atlantic (Figure 2.3). These areas were chosen to reflect fishing sites covered during the Irish deepwater survey programme in the 1990s and the area numbers correspond to these historic sampling sites. Two areas were located on the western continental slope (areas 2 & 4) and one area on the northern slope of the Porcupine Bank (area 5). In each area, a scientific sampling programme was conducted with depth stratified fishing tows carried out during day time and sampling for hydrography, water column biology and benthic ecology during night time. The Irish deepwater surveys were coordinated with the Scottish deepwater surveys which covers the slope in area VIa from 55° to 58.5°N.

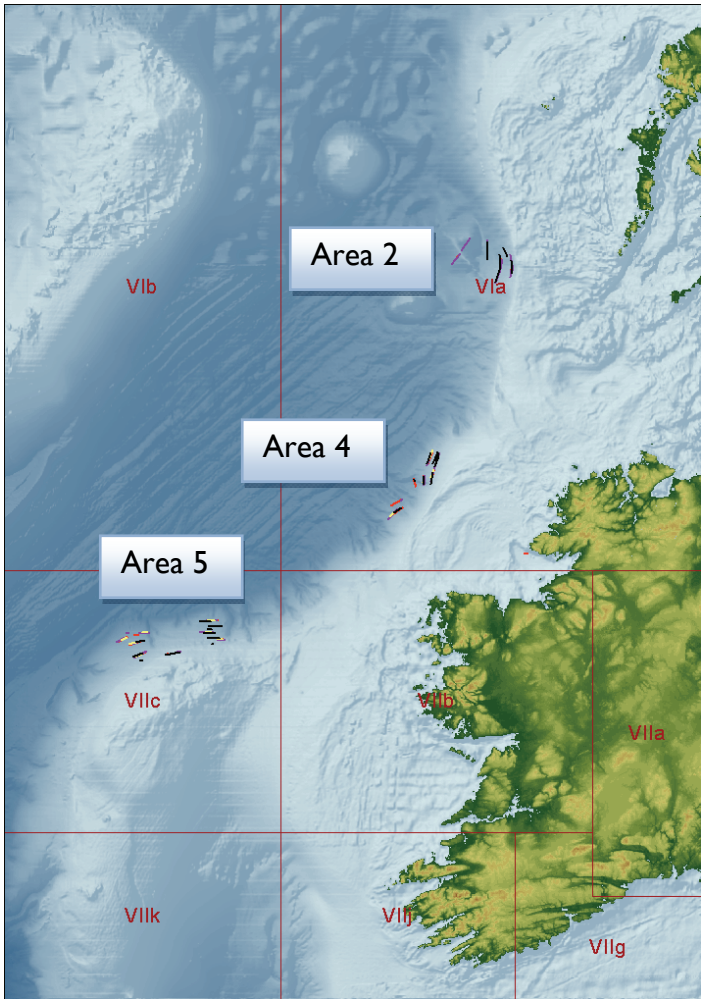


Figure 2.3 **Study areas and haul positions during the Irish deepwater survey 2006 to 2009. The fishing tows are colour coded by year, black is 2006, red is 2007, purple is 2008 and yellow is 2009.**

In each area, trawl hauls were conducted at four depths: 500m, 1000m, 1500m and 1800 meters. The fishing gear used was a Jackson trawl with heavy groundgear (D-gear) and Scanmar net monitoring sensors. The doors used were Morgere PF10 1400 kg doors (area 5.4 m). Information on possible clean fishing tows (i.e. limited trawl damage from rocky ground etc.) was derived from earlier surveys conducted in the 1990s, the Scottish survey and from commercial data. Information on tows at 1800m was only available for

Area 2, so finding equivalent tows in Areas 4 and 5 involved surveying the areas during the night to find potentially clear areas. The effective fishing time was set at two hours and was taken from when the trawl doors settled on the seafloor, to the net being hauled. In 2009, after analysis of the Irish and Scottish data, PGNEACS recommended reducing the fishing time to one hour for the 2009, and subsequent surveys.

Sample collection

At each station the entire catch was identified to species level and weighed. In case of difficulties with species identification, specimens were tagged and stored for further identification. For each species a random sample was taken for length measurements. Due to the great variety of body shapes of deep-water fish species, (see images in section 4) and the fragility of their tails and fins, several different length measurements were used (Table 2.2).

Table 2.2 Length measurement details for deepwater species on the IDS.

Species	Length Measurement
Sharks	total length
Skates	total length
Chimaeras	snout to pre supra caudal fin
Grenadiers	snout to base of anal fin
Bony fish	total length
Orange Roughy	total length
Black Scabbard	total length.
Smoothheads	standard length
Rhinochimaerids	snout to second dorsal fin
Searsids	standard length

Biological sampling (weight, sex, maturity, and age) was carried out on the target species: blue ling, black scabbard, leafscale gulper shark, hake, common ling, monkfish, Portuguese shark, orange roughy, roundnose grenadier and tusk. Additional sampling of weight, sex, maturity but not age was carried out on a number of other species over the years.

Benthic sediment samples were collected using a box corer on the 2006 and 2007 surveys, but this work was discontinued in 2008 and 2009. The equipment was bulky and difficult to use and didn't always produce reliable samples. However on each survey benthic invertebrates from the fishing hauls were collected. These were speciated and photographs were taken for a species identification catalogue. A species list was generated and levels of abundance were assigned to each species. Invertebrates chosen for a reference collection were preserved in either alcohol or 4% buffered formaldehyde. 155 species of invertebrates were recorded over the surveys. Crustacea and Echinodermata were the most dominant in terms of species numbers and biomass. There appears to be no obvious relationship between number of species and depth, although it would appear that the number of species is more variable in deeper waters.

3 Summary Information on Fish Catches

The following section summarises the survey results from the groundfish and deepwater surveys in terms of fish species abundance and distribution trends. The data are presented in the form of summary tables, Tables 3.2 and 3.3, which will give an overview of the most important and widespread species that are caught on the two surveys.

To establish trends in abundance, a minimum time series of five years is generally required. This is to allow enough time for a number of year classes to mature to fishable size, pass through the fishery and ideally contribute to overall stock biomass in terms of spawning. The deepwater survey was only carried out for four years and therefore trends are not presented.

Table 3.1 shows how to interpret the summary tables, (Table 3.2 and 3.3), on species abundance and occurrence:

Table 3.1 Explanation for each column of the species summary table.

Summary table on species abundance and occurrence	
Column	**Explanation**
Species **Common Name** **Scientific Name**	The 50 most abundant species are summarised in this table. Species are reported with their common names and scientific names. They are ranked according to their overall abundance in the survey.
Raised no CPUE **RSE**	The raised number **Catch Per Unit Effort (CPUE)** is the average number caught per survey hour, of that species, averaged over the whole survey area and time series. The **RSE** is the **relative standard error** of the CPUE, ie 100% * standard error / average CPUE
RSE across years	The RSE across years is the **relative standard error** of the annual mean CPUE, and gives an indication of how much the mean annual species abundance varied between years. A high RSE suggests that species are very variable in between years, while a low RSE indicates species abundance is stable over time.
% Occurrence **RSE % Occurrence**	This is a measure of how widely a species is distributed; **% occurrence** is the number of hauls at which a species is found divided by the total number of hauls carried out. A high value indicates that a species is widely distributed; a low value shows that a species is more concentrated in certain areas. The **relative standard error of % occurrence** measures how much the occurrence of a species varies over time. For example a low RSE with a high % occurrence indicates that species is evenly distributed over the survey area and throughout the survey time series.

Observations on the table:

The most abundant species on the Irish Groundfish survey is Norway pout. This is a small important prey item for some of the large gadoids, but not currently exploited commercially. A similar species in terms of taxonomic status and ecological importance is poor cod, which ranks sixth in overall abundance. Several pelagic species rank high in abundance, in particular mackerel, blue whiting, sprat and boar fish. In fact the main pelagic species are all in the upper 12 species. Haddock is the most abundant demersal species, which is commercially exploited. It is the fourth most abundant species overall. In terms of commercial demersal species, it is followed by whiting and hake. More details on all of these species can be found in the individual species sections.

Norway pout is the most abundant species and hake is the most widespread species on the IGFS.

The **relative standard error (RSE)** of the CPUE varies significantly among the different species and gives an indication of how variable the catches are. The RSE on the CPUE of some pelagic species such as sprat and herring tend to be particularly high as the species shoal in the water column. Hence the catches are sporadic and can be dominated by a few very large hauls. The RSE of CPUE between years measures how much the mean CPUE changes across years. Several species such as hake, megrim, lemon sole and red gurnard are characterised by very low RSEs suggesting that there is a high temporal stability in their catches. Other species fluctuate over the years and therefore have a high RSE e.g. sandeel, pipefish and argentines. Hake is the most widespread species on the groundfish survey, followed by poor cod and horse mackerel.

On the deepwater survey, roundnose grenadier is the most abundant species with a CPUE which is almost four times that of the second highest ranking species. This is one of the few deepwater species for which there are still viable commercial fisheries. Other grenadiers such as smooth rattail, spearsnouted grenadier and Günther's grenadier are ranked at 2, 11 and 12. Other abundant deepwater species are Smooth rattail, Baird's smoothhead, *Lepidion eques*, Rabbit fish, *Synaphobrnchus kaupi* and black scabbard, of which only black scabbard are commercial. Argentines are the 5th most abundant. This species is semi pelagic and supports large fisheries in Nordic waters. Widespread species are *Chimaera monstrosa,* Roundnose grenadier, *Lepidion eques, Synaphobranchus kaupi* and black scabbard.

All these species occur in over 70% of all stations. Although far less abundant than the species mentioned above, Bonapart's spiny eel is also very widespread, occurring in ¾ of all hauls. Overall, the CPUE values of deepwater species have much higher RSEs than the species on the groundfish surveys. This is due to several reasons. Deepwater species are highly depth aggregated and a survey which samples along depth transects ranging from 500m to 1800m will produce highly variable CPUE indices along the different depth bands. In addition the total number of hauls per year is much smaller than on the IGFS, which increases the variability of the estimates.

Roundnose grenadier is the most abundant species and *Chimaera monstrosa* is the most widespread species on the IDS.

Table 3.2 The 50 most abundant species on the IGFS (CPUE≥0.1h^{-1}), with details on abundance, occurrence and variability. For details on column header, see explanatory Table 3.1.

Rank	Common Name	Scientific Name	Mean CPUE	RSE CPUE %	RSE CPUE between years	% Occurrence	RSE % occurrence between years
1	Norway pout	*Trisopterus esmarki*	3383	19	43	63	6
2	Blue whiting	*Micromesistius poutassou*	2945	12	20	73	3
3	(european) mackerel	*Scomber scombrus*	1466	23	20	62	6
4	Haddock	*Melanogrammus aeglefinus*	1126	8	26	85	2
5	Sprat	*Sprattus sprattus*	1004	56	33	26	7
6	Poor cod	*Trisopterus minutus*	987	6	19	89	2
7	Horse-mackerel (scad)	*Trachurus trachurus*	949	13	13	87	4
8	Boarfish	*Capros aper*	942	28	19	57	4
9	Whiting	*Merlangius merlangus*	848	12	13	73	3
10	Grey gurnard	*Eutrigla (chelidonicthys) gurnardus*	607	15	18	85	3
11	Herring	*Clupea harengus*	376	42	46	41	6
12	Silvery pout	*Gadiculus argenteus*	240	12	21	50	8
13	Hake	*Merluccius merluccius*	183	6	11	92	1
14	Lsr silver smelt	*Argentina sphyraena*	161	14	15	73	4
15	Dab	*Limanda limanda*	123	16	15	47	5
16	Lesser spotted dogfish	*Scyliorhinus canicula*	78	5	12	86	3
17	American plaice (Ir dab)	*Hippoglossoides platessoides*	68	13	15	40	6
18	Common dragonet	*Callionymus lyra*	67	8	15	74	4
19	European plaice	*Pleuronectes platessa*	45	14	21	51	6
20	Thickback sole	*Microchirus variegatus*	31	8	12	66	2
21	Hollow nosed rattail/saddled	*Coelorinchus coelorhincus*	30	66	52	11	25
22	Spotted dragonet	*Callionymus maculatus*	29	8	11	61	2
23	Megrim	*Lepidorhombus whiffiagonis*	27	4	9	81	1
24	Lemon sole	*Microstomus kitt*	24	11	9	56	2
25	Red gurnard	*Aspitrigla (chelidonichthys) cuculus*	22	11	7	57	3
26	Blue-mouth redfish	*Helicolenus dactylopterus*	21	39	19	20	9
27	Gt silver smelt	*Argentina silus*	15	27	30	28	12
28	Snake pipefish	*Entelurus aequoreus*	12	28	66	20	48
29	Sandeels	*Ammodytidae*	9.4	768	186	2	112
30	Pilchard	*Sardina pilchardus*	8.3	262	83	7	28
31	John dory	*Zeus faber*	6.7	12	9	57	4
32	Pearlside	*Maurolicus muelleri*	6.5	113	44	13	21
33	Great pipefish	*Syngnathus acus*	6.4	62	132	8	122
34	Argentines	*Argentinidae*	6	290	146	3	106
35	Witch	*Glyptocephalus cynoglossus*	5.4	29	19	32	6
36	Greater sandeel	*Hyperoplus lanceolatus*	5.3	286	60	5	30
37	Saithe	*Pollachius virens*	4.9	59	26	15	9
38	Spotted ray	*Raja montagui*	4.5	17	9	29	9
39	Scald fish	*Arnoglossus laterna*	3.8	71	45	22	20
40	Four spot megrim	*Lepidorhombus boscii*	3.7	20	22	19	9
41	Immaculate sandeel	*Hyperoplus immaculatus*	3.4	405	89	3	47
42	Atlantic cod	*Gadus morhua*	3.3	17	20	33	12
43	Monkfish (Angler)	*Lophius piscatorius*	3.1	5	17	57	10
44	European anchovy	*Engraulis encrasicolus*	2.7	532	88	3	30
45	Spurdog	*Squalus acanthias*	2.7	87	44	23	10
46	Thornback ray (roker)	*Raja clavata*	2.7	13	11	28	5
47	Whiting-pout (bib)	*Trisopterus luscus*	2.1	206	44	5	13
48	Cuckoo ray	*Leucoraja naevus*	1.9	10	10	31	8
49	Black Sole (dover sole)	*Solea solea*	1.9	13	17	28	9
50	Solenette	*Buglossidium luteum*	1.8	90	36	7	21

Table 3.3 The 50 most abundant species on the IDS, with details on abundance, occurrence and variability. For details on column header, see explanatory Table 3.1.

Rank	Species Common name	Scientific name	Mean CPUE	RSE CPUE %	RSE CPUE % between years	% Occurrence	RSE % OCC between years
1	Roundnose grenadier	*Coryphaenoides rupestris*	416	127	13	72	12
2	Smooth rattail	*Nezumia aequalis*	120	165	28	44	24
3	Baird's smoothhead	*Alepocephalus bairdii*	108	142	51	73	13
4		*Lepidion eques*	76	126	40	58	24
5	Greater silver smelt	*Argentina silus*	74	296	82	28	61
6	Blue mouth redfish	*Helicolenus dactylopterus*	71	444	104	32	43
7	Hollow nosed rattail	*Coelorinchus coelorhincus*	68	231	46	32	41
8	Rabbit fish	*Chimaera monstrosa*	48	184	34	76	11
9	Murray's rattail	*Trachyrincus murrayi*	46	177	34	49	19
10	Bluntsnout smoothhead	*Xenodermichthys copei*	45	329	61	45	34
11	Spearsnouted grenadier	*Coelorinchus labiatus*	38	146	62	68	16
12	Günther's grenadier	*Coryphaenoides guentheri*	27	173	37	41	24
13		*Alepocephalus agassizii*	27	778	297	10	89
14		*Synaphobranchus kaupi*	26	180	47	73	14
15	Blue whiting	*Micromesistius poutassou*	25	420	97	25	65
16	Black scabbard	*Aphanopus carbo*	23	185	17	72	26
17		*Halargyreus johnsonii*	19	242	50	52	29
18	Blackmouth dogfish	*Galeus melastomus*	16	259	44	27	56
19	Birdbeak dogfish	*Deania calcea*	14	214	40	51	30
20	Softskin smoothhead	*Rouleina attrita*	11	319	109	30	60
21	Greater forkbeard	*Phycis blennoides*	11	196	57	49	38
22		*Mora moro*	10	290	140	32	37
23	European hake	*Merluccius merluccius*	9	283	59	21	61
24	Mediterranean grenadier	*Coryphaenoides mediterraneus*	9	190	41	39	33
25	Smoothheads	*Rouleina sp.*	8	564	154	7	200
26	Silvery pout	*Gadiculus argenteus*	8	384	96	23	56
27	Orange roughy	*Hoplostethus atlanticus*	7	248	38	45	12
28	Horse mackerel	*Trachurus trachurus*	7	603	153	13	107
29	Ratfish	*Hydrolagus mirabilis*	7	168	7	44	23
30		*Centroscymnus crepidater*	6	215	44	54	32
31		*Etmopterus princeps*	6	194	74	48	38
32	Narrownose chimera	*Harriotta raleighana*	5	202	24	44	31
33	Bonapart's spiny eel	*Notacanthus bonaparte*	4	162	18	75	15
34	Lantern fishes	*Myctophidae*	4	247	71	62	11
35	Witch	*Glyptocephalus cynoglossus*	3	325	63	30	32
36	Bullseye	*Epigonus telescopus*	3	312	76	42	40
37	White catshark	*Apristurus aphyodes*	3	172	54	45	45
38	Spiderfish	*Bathypterois dubius*	3	184	55	39	11
39	Blue antimora	*Antimora rostrata*	3	176	49	41	22
40	Velvet belly	*Etmopterus spinax*	3	450	78	20	54
41	Blue ling	*Molva dypterygia*	2	128	28	68	16
42		*Cataetyx laticeps*	2	213	36	38	25
43		*Apristurus laurussoni*	2	234	224	32	77
44	Smalleyed rabbitfish	*Hydrolagus affinis*	2	231	50	30	49
45		*Holtbyrnia anomala*	1	450	147	17	87
46		*Centroscyllium fabricii*	1	295	67	18	79
47	Pudgy cuskeel	*Spectrunculus grandis*	1	334	87	13	67
48	Portuguese shark	*Centroscymnus coelolepis*	1	182	64	42	39
49	Common ling	*Molva molva*	1	252	50	18	46
50	Snake pipefish	*Entelurus aequorus*	1	172	103	41	122

Table 3.4 shows how to interpret the summary table, (Table 3.5), on biomass and abundance trends of the groundfish survey:

Table 3.4 Explanation for each column of the species summary table.

Summary table on species abundance trends	
Column	**Explanation**
Species **Common Name** **Scientific Name**	The most important commercial and ecologically important species caught on the IGFS are listed in the table. These are the same species that are described in the detailed species section.
Strata	For the detection of trends, the abundance and biomass data per species is split into VI and VII strata, as these are sampled at slightly different times with different ground gears and therefore equal catching efficiency for all species cannot be guaranteed.
Valid Tows	The number of tows in the time series per area strata that are used in the analysis.
Kg/hours y_i/y_{i-1} $y_{(i,i-1)}/ y_{(i-2,i-3,i-4)}$	This is a biomass index which measures the catch weight (kg) of a species standardised to one hour tows. The catch weight of the current year divided by the catch weight of the previous year in %. This value gives an indication of how much the biomass of a species has changed in the previous year and is presented with a traffic light: orange indicates that the biomass has decreased by more than 15%, green indicates that the biomass has increased by 15% or more. The mean catch weight of the last two years divided by the mean catch weights of the previous three years in %. This value gives an indication of how much the biomass of a species has changed in the last five years. Colour coding is the same as above.
No/hours y_i/y_{i-1} $y_{(i,i-1)}/ y_{(i-2,i-3,i-4)}$	This is an abundance index which measures the mean numbers of a species standardised to one hour tows. The abundance of the last year divided by the abundance of the previous year in %. This value gives an indication of how much the abundance of a species has changed in the previous year and is presented with a traffic light: orange indicates that the abundance has decreased by more than 15%, green indicates that the abundance has increased by 15% or more. The mean abundance of the last two years divided by the mean abundance of the previous three years in %. This value gives an indication of how much the abundance of a species has changed in the last five years. Colour coding is the same as above.

Observations on the table:

Of the 29 species in subarea VIa 14 showed a five year increase in biomass and 12 species showed an increase in numbers. In subarea VII, 16 out of 29 species showed an increase in biomass over the five years, while 13 species showed an increase in numbers. This indicates that the majority of species were either stable or increased in biomass and numbers and that overall there were about twice as many species increasing than decreasing in biomass and numbers in the last five years.

In area VIa boarfish, haddock, herring, mackerel, plaice and sole exhibited very strong increases in the last five years, both in numbers and in biomass. Biomass values for most commercial species were either stable or increased in VIa, with the exception of lemon sole and monkfish. Cod, lemon sole and hake decreased significantly in numbers in the last five years. In subarea VII, cod, herring, monkfish, plaice and sole all showed significant increases in numbers and biomass in the last five years with cod increasing almost fivefold in numbers. Hake, horse mackerel and blue whiting demonstrated strong decreases in biomass and numbers.

Table 3.5 Temporal trends in abundance and biomass of selected fish species caught on the IGFS.

Biomass and number estimates										
				Biomass index			Number index			
Common Name	Species Name	Strata	Valid tows	y_i	y_i/y_{i-1}	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$	y_i	y_i/y_{i-1}	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$	
				kg/Hr	%	%	No/Hr	%	%	
Boar fish	*Capros aper*	VIa	49	42.9	998.0	364.0	828.2	1026.0	328.2	
Common dragonet	*Callionymus lyra*	VIa	49	0.6	8.8	-50.3	14.5	16.2	-49.8	
Atlantic cod	*Gadus morhua*	VIa	49	5.1	-31.3	-2.4	3.4	-39.1	-21.2	
Cuckoo ray	*Leucoraja naevus*	VIa	49	1.3	-52.8	-4.3	1.6	-50.9	-15.6	
Dab	*Limanda limanda*	VIa	49	9.1	48.1	64.1	125.9	33.4	38.5	
Spurdog	*Squalus acanthias*	VIa	49	4.0	-10.6	36.2	2.8	11.3	55.9	
Grey gurnard	*Eutrigla (chelidonicthys) gurnardus*	VIa	49	19.4	3.2	-19.8	206.0	-18.4	-23.0	
Haddock	*Melanogrammus aeglefinus*	VIa	49	140.2	177.1	103.8	465.4	163.6	115.6	
Herring	*Clupea harengus*	VIa	49	579.9	1388.5	800.4	3192.6	1013.0	427.3	
European hake	*Merluccius merluccius*	VIa	49	19.2	-46.9	-4.5	31.4	-68.7	-45.5	
Horse-mackerel (scad)	*Trachurus trachurus*	VIa	49	496.5	266.5	10.8	2765.4	357.3	-9.9	
John dory	*Zeus faber*	VIa	49	9.0	78.7	7.5	14.3	75.9	9.0	
Four spot megrim	*Lepidorhombus boscii*	VIa	49	0.0	NA	NA	0.0	NA	NA	
Lemon sole	*Microstomus kitt*	VIa	49	3.6	-0.9	-34.4	32.1	0.5	-43.9	
Lesser spotted dogfish	*Scyliorhinus canicula*	VIa	49	71.9	18.6	28.9	178.9	-0.9	28.0	
Mackerel (European)	*Scomber scombrus*	VIa	49	274.2	56.6	98.0	2053.9	101.0	118.3	
Megrim	*Lepidorhombus whiffiagonis*	VIa	49	2.3	31.8	32.2	8.4	14.2	4.9	
Monkfish (Angler)	*Lophius piscatorius*	VIa	49	1.8	30.3	-37.0	1.0	-12.3	4.8	
Norway pout	*Trisopterus esmarki*	VIa	49	221.4	47.6	94.4	11221.5	117.5	-16.3	
European plaice	*Pleuronectes platessa*	VIa	49	18.1	33.0	111.5	119.4	20.4	137.4	
Poor cod	*Trisopterus minutus*	VIa	49	10.7	-14.6	-57.5	1009.0	147.6	-65.7	
Reticulate dragonet	*Callionymus reticulatus*	VIa	49	0.0	NA	NA	0.0	NA	NA	
Spotted dragonet	*Callionymus maculatus*	VIa	49	0.0	-74.7	-45.5	1.8	-70.6	-53.6	
Sole (dover sole)	*Solea solea*	VIa	49	0.7	41.1	107.3	2.6	20.2	91.6	
Sprat	*Sprattus sprattus*	VIa	49	0.9	2223.3	-90.3	158.2	9480.0	-80.4	
Thornback ray (roker)	*Raja clavata*	VIa	49	8.3	-22.3	96.9	6.5	-16.5	82.8	
Black-bellied anglerfish	*Lophius budegassa*	VIa	49	0.6	61.0	19.5	0.5	21.1	107.8	
Blue whiting	*Micromesistius poutassou*	VIa	49	84.3	-16.1	1.6	3918.5	13.3	23.9	
Whiting	*Merlangius merlangus*	VIa	49	62.7	-15.4	60.7	313.4	-38.6	-3.3	
Boar fish	*Capros aper*	VIIbgj	110	40.0	-40.6	2.5	839.2	-44.3	11.2	
Common dragonet	*Callionymus lyra*	VIIbgj	110	5.6	7.6	84.6	128.1	-11.8	110.7	
Atlantic cod	*Gadus morhua*	VIIbgj	110	11.8	139.7	263.4	6.4	6.3	483.5	
Cuckoo ray	*Leucoraja naevus*	VIIbgj	110	1.5	0.7	-19.7	1.3	-30.0	-16.2	
Dab	*Limanda limanda*	VIIbgj	110	12.7	125.6	41.5	267.4	164.3	43.7	
Spurdog	*Squalus acanthias*	VIIbgj	110	2.0	12.7	-15.3	1.0	-25.7	-5.3	
Grey gurnard	*Eutrigla (chelidonicthys) gurnardus*	VIIbgj	110	68.9	47.1	65.8	1174.7	10.4	48.1	
Haddock	*Melanogrammus aeglefinus*	VIIbgj	110	189.3	-32.5	51.6	881.1	-53.3	-36.2	
Herring	*Clupea harengus*	VIIbgj	110	23.8	-66.5	603.3	311.7	-68.4	865.4	
European hake	*Merluccius merluccius*	VIIbgj	110	15.7	-2.8	-43.5	262.7	21.5	1.4	
Horse-mackerel (scad)	*Trachurus trachurus*	VIIbgj	110	2.1	-96.3	-76.1	16.9	-96.4	-71.2	
John dory	*Zeus faber*	VIIbgj	110	2.4	-7.4	6.2	4.5	15.8	-12.1	
Four spot megrim	*Lepidorhombus boscii*	VIIbgj	110	0.2	-59.9	2.9	3.4	-52.1	-11.2	
Lemon sole	*Microstomus kitt*	VIIbgj	110	2.3	22.9	3.5	14.1	14.2	-6.8	
Lesser spotted dogfish	*Scyliorhinus canicula*	VIIbgj	110	38.3	20.2	58.4	80.4	9.5	48.1	
Mackerel (European)	*Scomber scombrus*	VIIbgj	110	103.5	-27.8	11.5	3158.2	49.1	217.8	
Megrim	*Lepidorhombus whiffiagonis*	VIIbgj	110	5.7	23.2	20.4	29.6	0.6	-9.4	
Monkfish (Angler)	*Lophius piscatorius*	VIIbgj	110	7.0	7.7	63.6	6.6	11.3	165.9	
Norway pout	*Trisopterus esmarki*	VIIbgj	110	54.6	-13.0	110.5	2180.5	9.1	11.9	
European plaice	*Pleuronectes platessa*	VIIbgj	110	10.0	4.7	54.3	60.0	-1.2	56.3	
Poor cod	*Trisopterus minutus*	VIIbgj	110	17.5	-21.8	-18.1	803.0	32.5	-28.3	
Reticulate dragonet	*Callionymus reticulatus*	VIIbgj	110	0.0	NA	NA	0.0	NA	NA	
Spotted dragonet	*Callionymus maculatus*	VIIbgj	110	0.3	-42.5	53.4	34.1	-39.3	35.2	
Sole (dover sole)	*Solea solea*	VIIbgj	110	0.8	35.4	87.4	3.6	45.8	86.4	
Sprat	*Sprattus sprattus*	VIIbgj	110	1.5	-94.5	20.5	218.4	-93.5	55.0	
Thornback ray (roker)	*Raja clavata*	VIIbgj	110	2.4	2.7	-21.0	1.6	-10.8	-28.3	
Black-bellied anglerfish	*Lophius budegassa*	VIIbgj	110	1.5	-53.9	25.7	2.2	-18.9	24.4	
Blue whiting	*Micromesistius poutassou*	VIIbgj	110	40.3	-39.2	-43.0	2039.2	6.4	-42.1	
Whiting	*Merlangius merlangus*	VIIbgj	110	185.6	52.6	65.9	1373.6	72.0	-14.7	

Legend

- Increase
- Decrease
- <15% Change

4 Summary of Results by Species

The following section describes the biology, distribution and abundance patterns of the most important species caught on the Irish ground fish survey and the Irish deepwater survey. Species are grouped into several categories:

- Commercial demersal species
- Pelagic species
- Non commercial demersal species
- Elasmobranchs (i.e. rays, skates and sharks)
- Deepwater species

In each category, the sequence of species is determined by their mean landings in the survey area between 2005 and 2011. The following table gives an overview of the species in each category, which survey was used to provide data for its description and where it can be found in the atlas.

Table 4.1 Details of species sections including species category, data source and page number.

Overview of species sections				
Species Category	**Species Common Name**	**Species Scientific Name**	**Survey**	**Page No**
Commercial demersal species	Whiting	*Merlangius merlangius*	IGFS	19
	Haddock	*Melanogrammus aeglefinnus*	IGFS	20
	Monkfish	*Lophius piscatorius & Lophius budegassa*	IGFS	21
	Megrim	*Lepidorhombus whiffiagonis & Lepidorhombus boscii*	IGFS	22
	Hake	*Merluccius merluccius*	IGFS	23
	Atlantic cod	*Gadus morhua*	IGFS	24
	European Plaice	*Pleuronectes platessa*	IGFS	25
	Black sole	*Solea solea*	IGFS	26
Pelagic species	Boarfish	*Capros aper*	IGFS	27
	Mackerel	*Scomber scombrus*	IGFS	28
	Horse Mackerel	*Trachurus trachurus*	IGFS	29
	Blue Whiting	*Micromesistius poutassou*	IGFS	30
	Herring	*Clupea harengus*	IGFS	31
	Sprat	*Sprattus sprattus*	IGFS	32
Non commercial demersal species	Lemon sole	*Microstomus kitt*	IGFS	33
	John Dory	*Zeus faber*	IGFS	34
	Grey Gurnard	*Eutrigla gurnardus*	IGFS	35
	Dab	*Limanda limanda*	IGFS	36
	Norway pout	*Trisopterus esmarki*	IGFS	37
	Poor cod	*Trisopterus minutus*	IGFS	38
	Dragonet	*Callionymus spp.*	IGFS	39
Elasmobranchs	Spurdog	*Squalus acanthias*	IGFS	40
	Lesser spotted dogfish	*Scyliorhinus canicula*	IGFS	41
	Thornback ray	*Raja clavata*	IGFS	42
	Cuckoo ray	*Leucoraja naevus*	IGFS	43
Deepwater species	Black scabbard	*Aphanopus carbo*	IDS	44
	Roundnose grenadier	*Coryphaenoides rupestris*	IDS	45
	Greater forkbeard	*Phycis blennoides*	IDS	46
	Orange roughy	*Hoplostethus atlanticus*	IDS	47
	Blue Ling	*Molva dypterygia*	IDS	48
	Portuguese dogfish	*Centroscymnus coelolepis*	IDS	49
	Leafscale gulper shark	*Centrophorus squamosus*	IDS	50

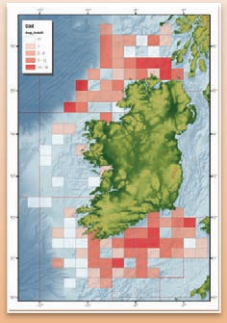
The images in the species sections come from the following sources:

- Most illustrations (i.e. if not otherwise stated) come from "Day, F. (1880-1884). The fishes of great Britain and Ireland. Volumes 1 and 2. Williams and Norgate, London".
- Norway pout and blue ling illustrations come from the FAO Species Catalogue, "FAO Fisheries Synopsis No. 125, Volume 10: Gadiform fishes of the world (1990)" and the permission of the Food and Agriculture Organization of the United Nations to reproduce the images is kindly acknowledged.
- Black Scabbard and Leafscale gulper shark illustrations are reprinted from "Günther, A. C. L. G. (1830-1914). Report on the deep-sea fishes collected by H.M.S. Challenger during the years 1873-1876".
- The illustration of Orange Roughy comes from "Maguire, J. J., Sissenwine, M., Csirke, J., Grainger, R., Garcia, S., 2006. The state of world highly migratory, straddling and other high seas fishery resources and associated species. FAO Fisheries technical Paper, No. 495, 84pp".
- The illustration of the Portuguese dogfish is reprinted from "The Plagiostomia : Sharks, skates, and rays. Cambridge, U.S.A.: Printed for the Museum,1913". Image courtesy of Biodiversity Heritage Library. http://www.biodiversitylibrary.org.

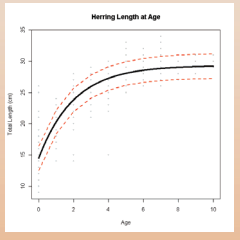
Further details on the Irish ground fish surveys including annual distribution maps of different species can be found at:
http://www.marine.ie/home/publicationsdata/data/WebMapServices/IrishGroundFishSurveyViewer.htm

Further details on the Irish deepwater surveys including annual distribution maps of different species can be found at:
http://www.marine.ie/home/publicationsdata/data/WebMapServices/DeepWaterSurveyViewer.htm

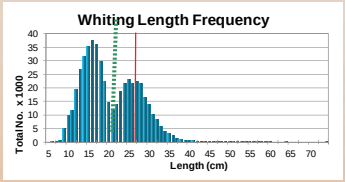
How to interpret the maps and graphs for the IGFS species:



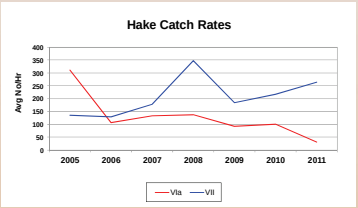
Ground **fish distribution** maps are gridded mean CPUEs h^{-1} from surveys between 2005 and 2011. For the commercial species, data is split and presented for juveniles (left panel) and adults (right panel). All legends use a sliding scale in colour from red to white (where red represents the highest value on the scale and white represent the lowest value on that scale). **Note that the scale changes across species.**



This graph shows **modelled growth** per species, i.e. what size would a fish be at a certain age. It is based on age and length data from the survey (as shown by the black dots).



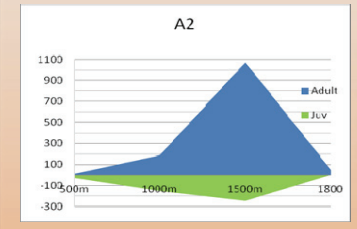
The **length frequency plots** show the total numbers of individuals caught in each size category between 2005 and 2011. The red line line represents minimum landings size. The dashed line is the threshold that is used to differentiate between juveniles and adults as used by IBTS.



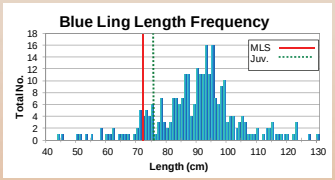
Catch per unit effort graphs show the changes in mean catch numbers per hour of each species from 2005 to 2011. Data is split between ICES subareas VI and VII.

How to interpret the maps and graphs for the IDS species:

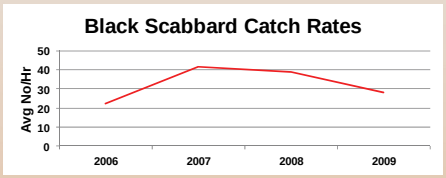
The map shows the **three sampling areas** of the Irish deepwater survey and the positions of the individual fishing tows.



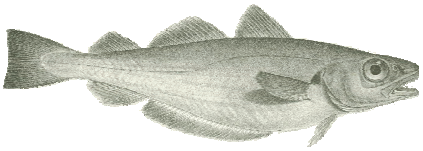
The **kite diagrams** show the numbers of fish caught per hour by depth in each area averaged over the four years. The data is presented for both adults and juveniles, with the adult data above the x-axis in blue, and the juvenile data below in green. The x-axis shows the depths at which the fishing took place.



The **length frequency histogram** displays the count of fish caught at each size class over the four years of the survey series. The red vertical bar indicates minimum landing size and the green bar the cut-off point between juveniles and adults. In the case of Portuguese dogfish and Leafscale Gulper shark separate histograms are presented for both males and females. This was due to the fact that the cut- off points for juveniles differs depending on the sex.

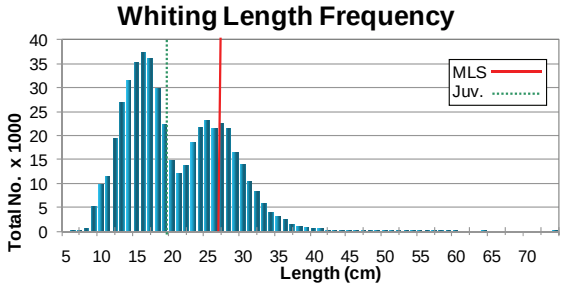


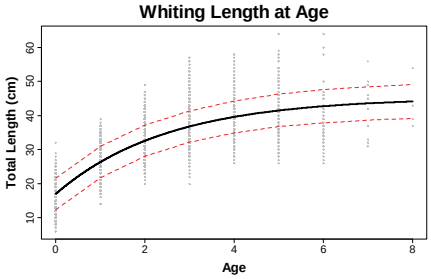
Catch per unit effort graphs show the changes in catch numbers per hour of each species from 2006 to 2009.



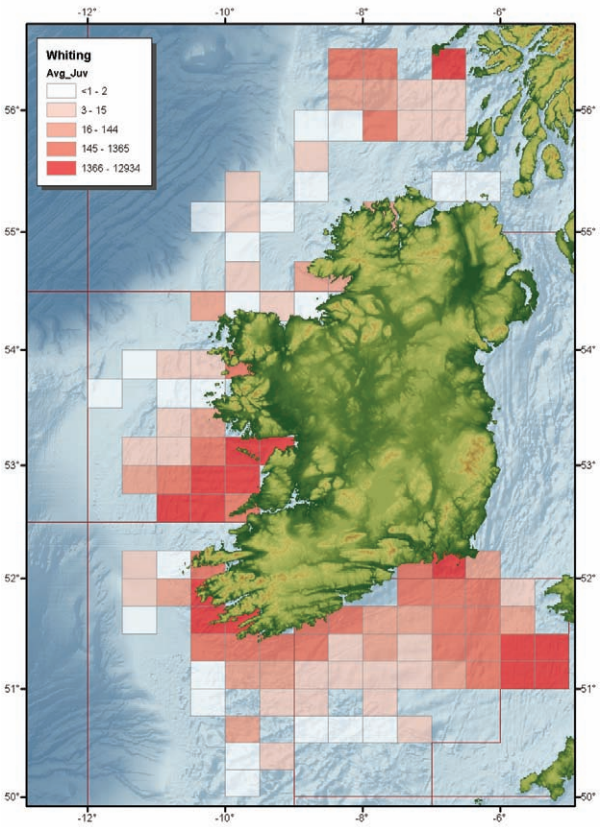
Whiting - *Merlangius merlangius*

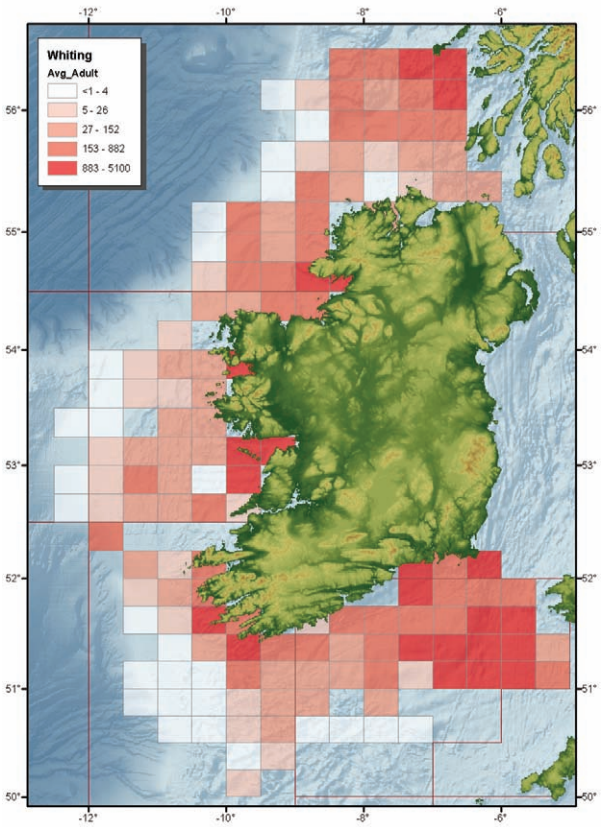
Biology – whiting are similar in size to cod and haddock, but their fine sharp teeth reflect a more predatory diet of small fish and crustaceans. They reach about 26cm in the first year. The length of whiting caught on the IGFS ranged between 6cm and 74cm with an average of 28cm. The minimum landing size (MLS) in whiting corresponds to fish in their second year. A significant proportion of the survey catch is below this limit and therefore a useful source of data on juvenile survival and recruitment. About 60% are mature as 1 yr olds, with 95% mature by age 2yrs. Fecundity is significantly higher in whiting than cod and haddock, with a 30cm whiting producing about half a million eggs.



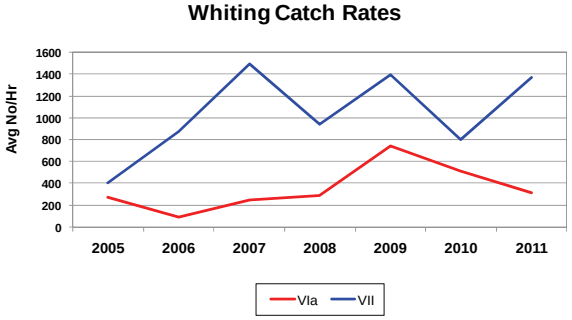


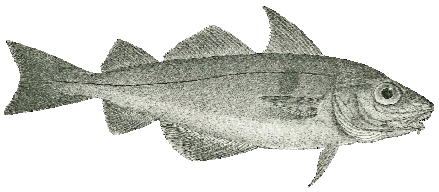
Distribution – whiting is common throughout the northeast Atlantic, from the Barents Sea and Iceland down to the southern Bay of Biscay. On the survey, juvenile whiting are mostly caught to the west and throughout the Celtic Sea. Adult fish are distributed more uniformly throughout the survey area and have been caught from 10m-312m, but generally < 100m.





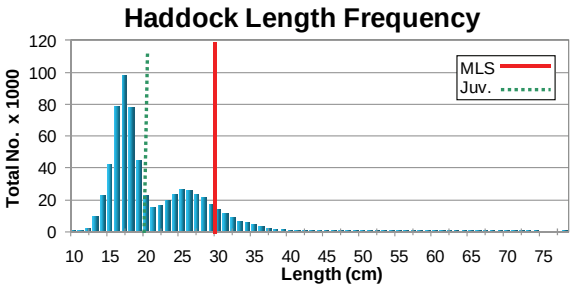
Catches – catch rates of whiting to the west of Ireland and off the south coast (VII) can vary between 1,000 to 1,500 fish per hour and have fluctuated in recent years without any clear trend. The survey catch rates in the northwest (VIa) are lower than those in the Celtic Sea (VII). Catch rates increased from 2006 to 2009 but declined in 2010 and 2011.

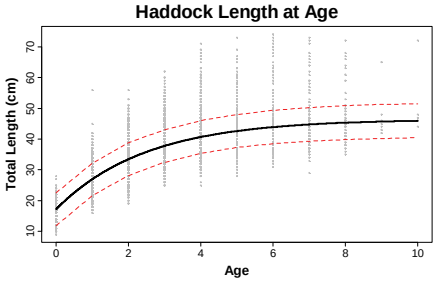




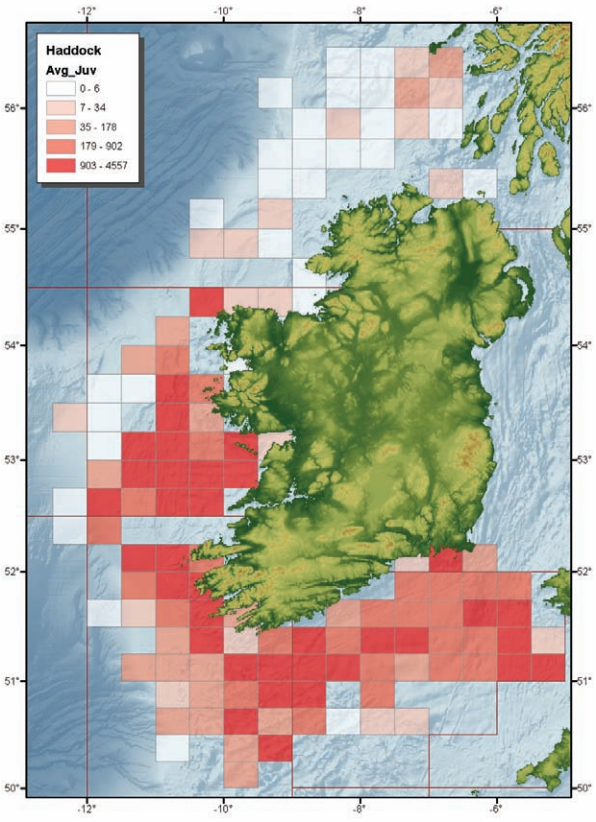
Haddock - *Melanogrammus aeglefinnus*

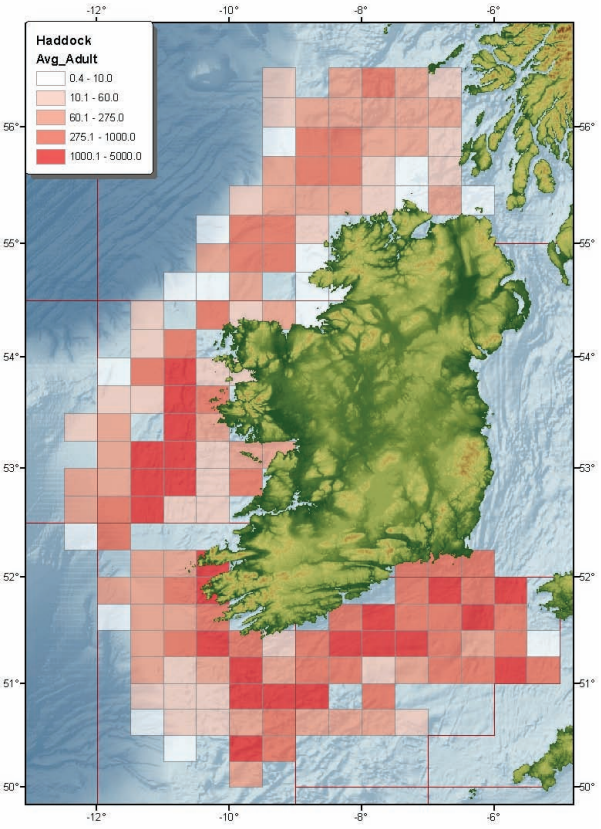
Biology – haddock are moderately large gadoids with a diet consisting largely of benthic molluscs, crustaceans, worms and small fish. Fish reach a length of around 27cm at one year of age. In the survey catches fish lengths ranged between 8 and 78 cm, with an average of 31cm. About 80% of fish are mature at 2 yrs, and 99% are mature by 3yrs of age. Maturity appears to depend more on age in females, but on length in males. An average female haddock can produce around 150 000 eggs per season. The survey captures a significant proportion of fish below the minimum commercial landing size (>90%), and is a valuable source of information for juvenile fish about to enter the fishery.



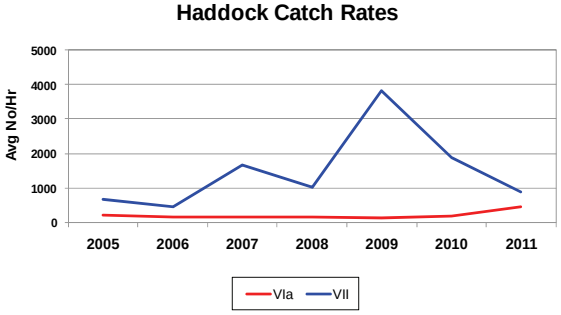


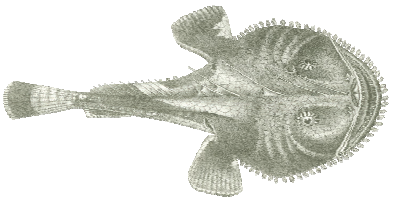
Distribution – from Barents Sea to the Bay of Biscay in the northeast Atlantic, and up to the Straits of Labrador off Canada. Haddock on the survey are mostly caught as juveniles to the west and throughout the Celtic Sea. Adult fish are found throughout the survey generally down to about 300m.





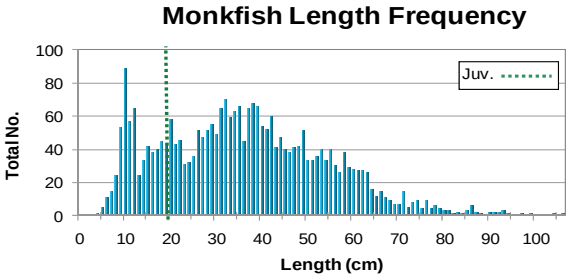
Catches – survey catch rates to the northwest have remained low and stable between 2005-2011, with only a fractional increase in recent years. Haddock stocks are known to oscillate significantly in year class abundance and this is evident in catches from the Celtic Sea and west of Ireland. The peak in abundance in 2009 was due to large numbers of juveniles that year, which still remain a significant component of the fishery.

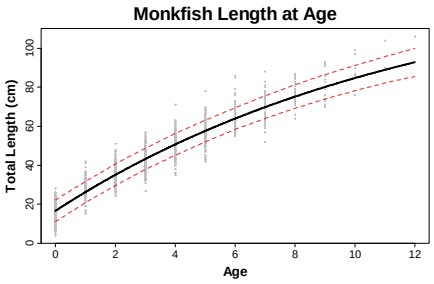




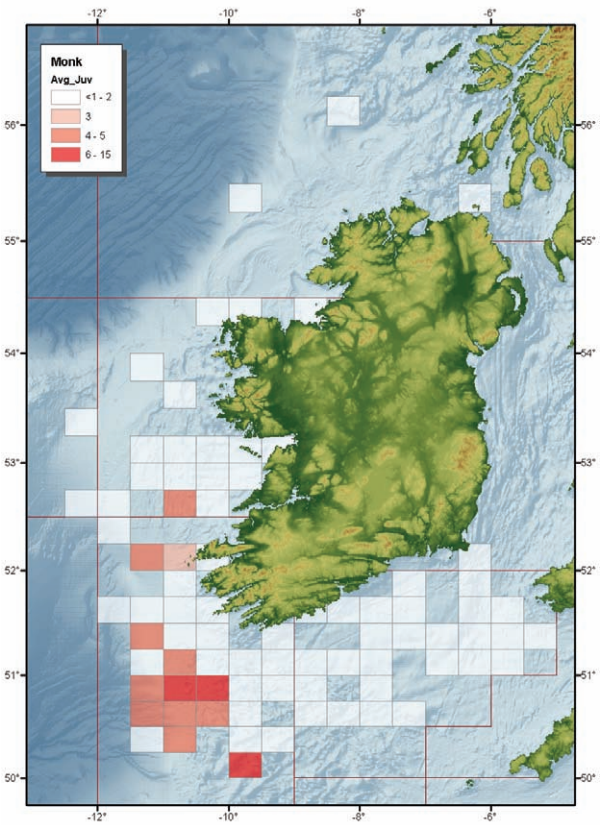
Monkfish - *Lophius piscatorius & Lophius budegassa*

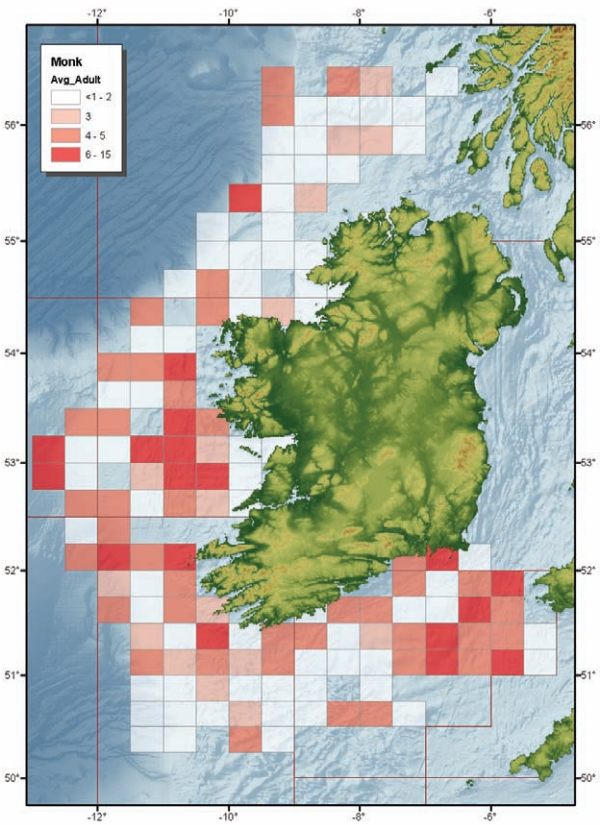
Biology – monkfish comprise two species and are distinguished by either a white (*L. piscatorius*) or black (*L. budegassa*) lining of the stomach. Therefore they are sometimes also referred to as white or black bellied anglerfish. The two species are caught and landed together. Growth is rapid and females are larger than males with max size of 121cm observed on the survey. *L. budegassa* is a smaller species and the maximum observed length has been 81cm. Sexual maturity occurs between the age of 5 to 9 years and eggs are shed in long gelatinous ribbons, 60-90cm wide and up to 9m long, which float in the water currents. Feeding occurs on the seabed with a modified fleshy spine at the top of its head being used to lure its prey.





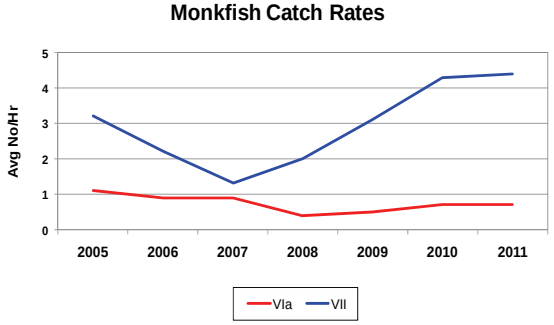
Distribution – *L. piscatorius* is a north eastern Atlantic species, with a distribution area from Norway (Barents Sea) to the Straits of Gibraltar. *L. budegassa* has a more southern distribution from the UK and Ireland to Senegal. Most survey catches are concentrated west, southwest and south of Ireland.

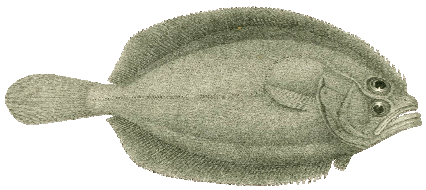




The depth range for *L. piscatorius* is from 17m – 750m (survey maximum) and for *L. budegassa* 55m – 500m.

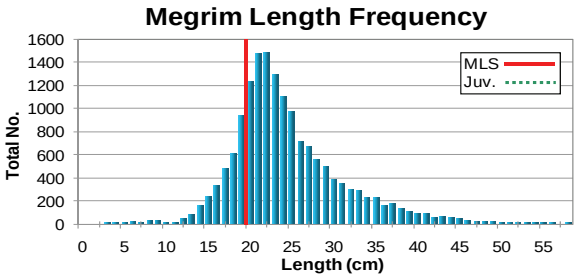
Catches – survey catch rates in the northwest region (VIa) have remained reasonably constant at ~1 fish per hour, while catches in VII have grown steadily since 2007 to 4 fish per hour. Commercially, monkfish are almost exclusively caught by otter and beam trawling, indicating that demersal trawls are an adequate sampling gear to catch these species.

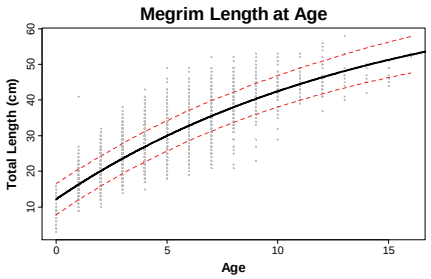




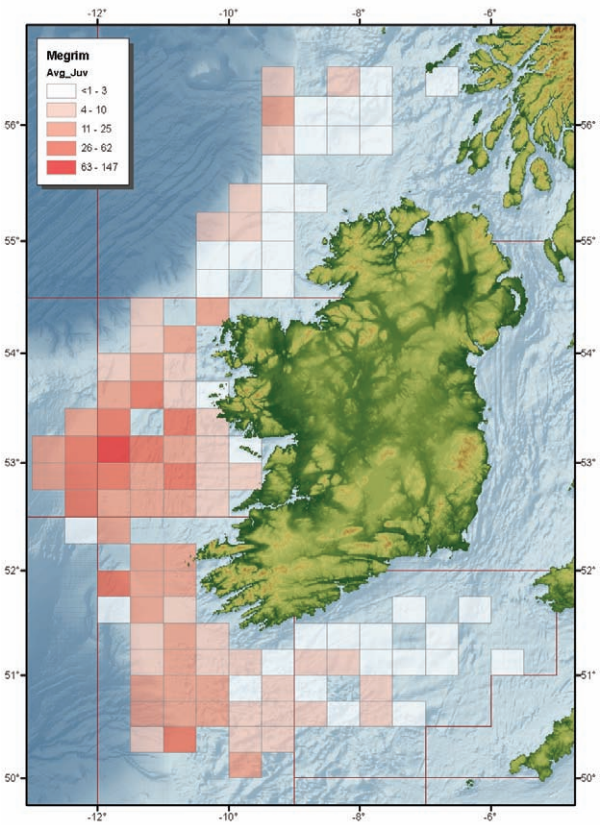
Megrim - *Lepidorhombus whiffiagonis & Lepidorhombus boscii*

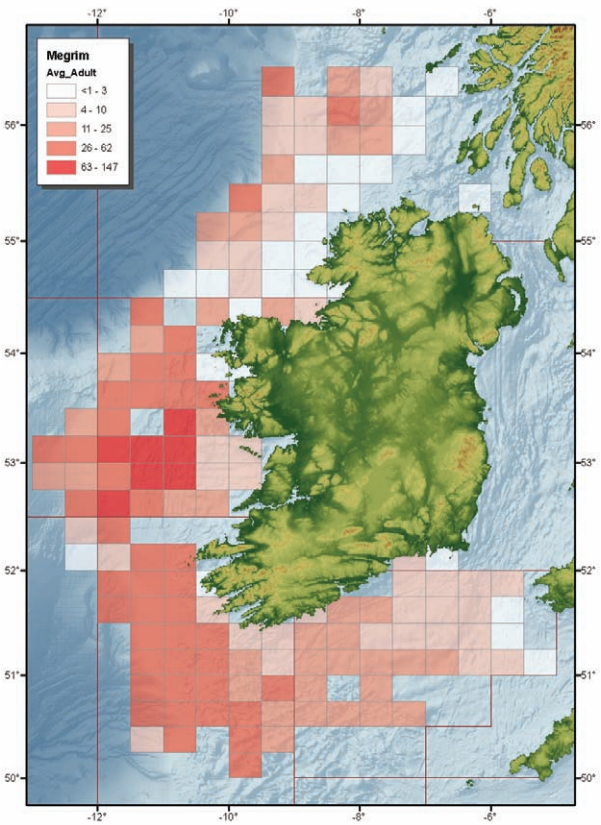
Biology – megrim are a deepwater flatfish generally associated with soft sediment. Two species of megrim occur in Irish waters *L. whiffiagonis,* and the lesser known *L. boscii* or four-spot megrim. The two species are regularly caught together. Females grow larger than males and survey data show a size range of 3 - 58cm for females and 4 - 40cm for males. Males are sexually mature by about 5 - 6 years of age, whilst females mature a bit later at around 6 - 7yrs. Megrim have comparatively large mouths relative to other flatfish and their diet consists largely of fish, with squid and crustaceans also being consumed.



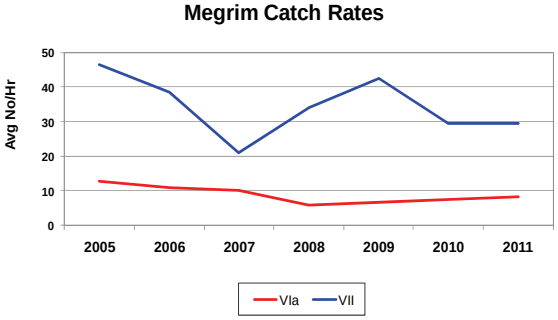


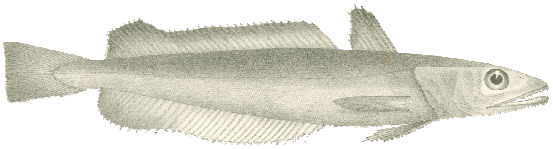
Distribution – megrim are distributed from Iceland and Norway down to northwest Africa, and into the western Mediterranean Sea. The survey has observed consistently higher numbers off the west coast than in other areas, and in general at depths from 120m to the survey maximum of 600m (distribution is likely to extend beyond this).





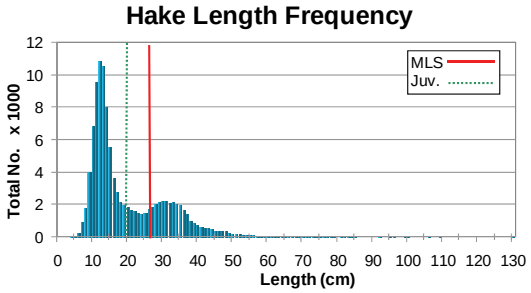
Catches – survey catch rates in the northwest (VIa) have declined slightly since 2005, but show little variation in most years. In contrast, megrim catches on the west coast and in the Celtic Sea (VII) have oscillated significantly, varying between about 20 – 50 fish per hour. Megrim try to avoid capture by moving laterally in relation to an approaching net and are therefore often seen in the wings (side-walls) of the trawl mouth. The relatively large meshes in the design of the survey trawl can therefore under sample the smaller megrim relative to the larger specimens. Nevertheless, >19% of the survey fish are smaller than the minimum landing size (MLS).



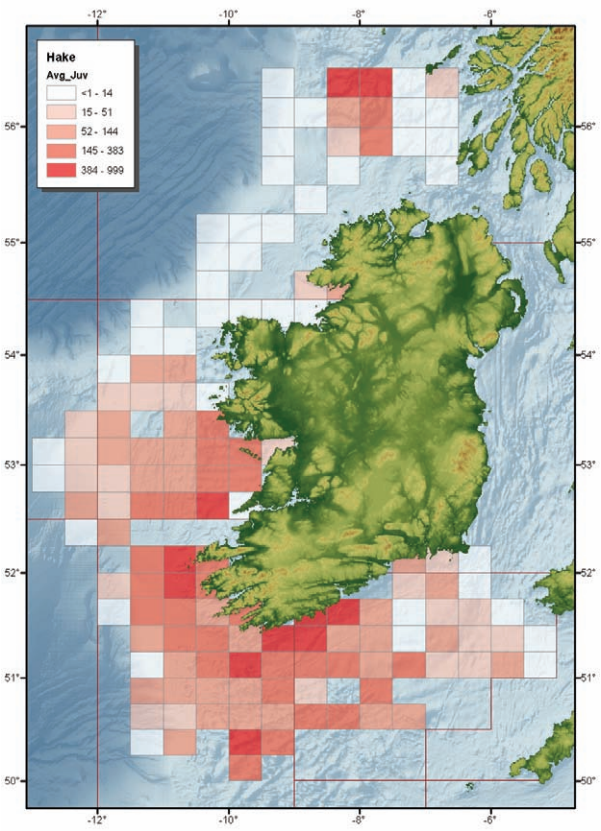


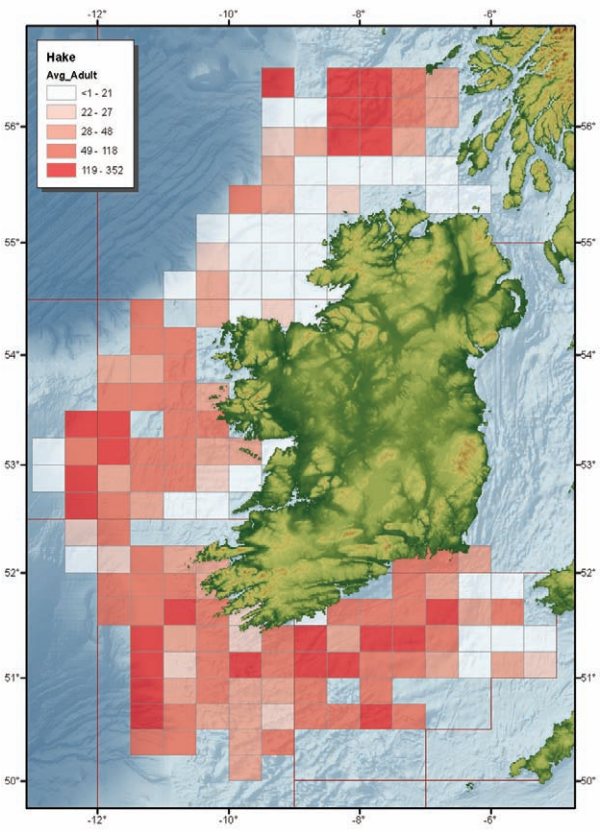
Hake - *Merluccius merluccius*

Biology – hake are a more elongate, slender bodied member of the cod family (gadoids). They are a predatory species, rather than a forager. Living near the seabed, hake ambush prey in the water column during vertical migrations mainly at night. Prey items include crustacea and shift more towards squid and small fish as they mature. Due to the difficulty in reading their bony structures, hake are difficult to age. Growth rates differ between males and females and while the average length for male hake on the survey is 34cm and 36cm for female, the maximum lengths are 83cm and 130cm respectively. A significant amount of data from the survey is provided for fish below the commercial minimum landing size (MLS).

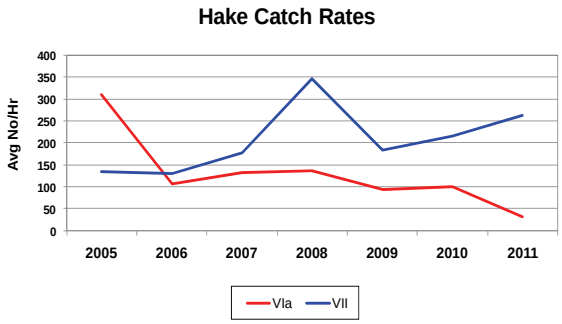


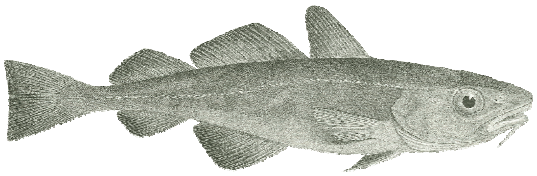
Distribution – hake are distributed from Iceland and Norway down to northeast Africa, and into the Mediterranean and Black Sea. In the IGFS, Juveniles are mostly caught off the southwest coast while the adult fish are encountered in the central Celtic Sea and in deeper waters along the shelf edge. There is also a more localised distribution of juveniles and adults in the northwest of Scotland.





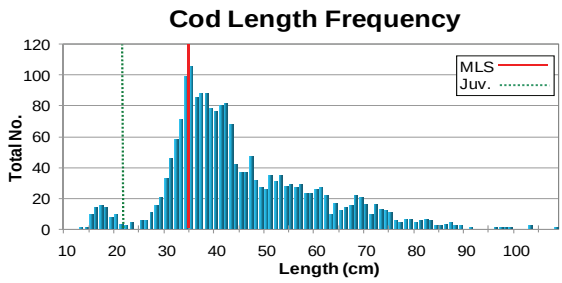
Catches – survey catches of hake in the north west (VIa) have declined since 2005 and remain at a low level. In the area to the west of Ireland and in the Celtic Sea (VII), a large input of juvenile fish was seen in 2008. This coincides with a similar peak in other groundfish surveys from Portugal to Scotland. Since then a return to the lower catch levels observed before the 2008 peak has been observed across surveys.

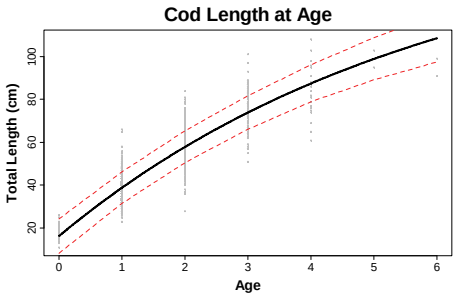




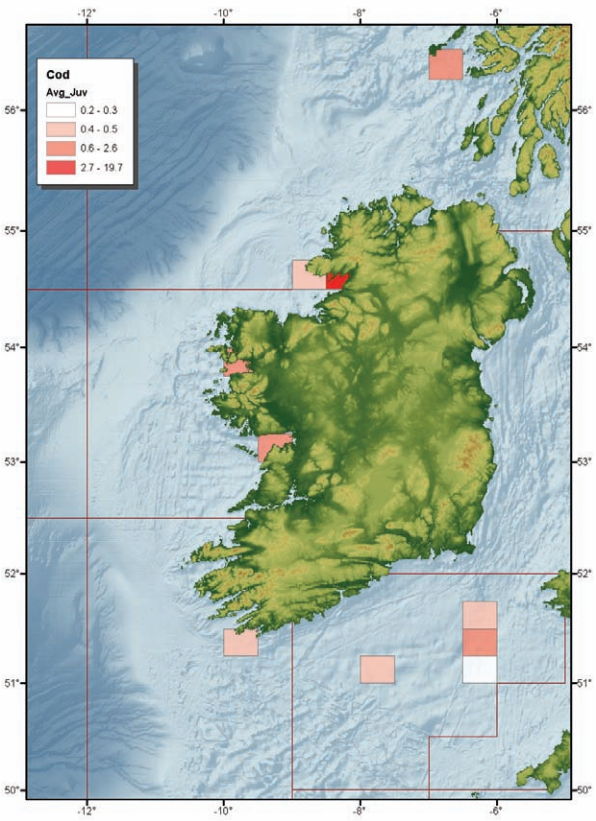
Atlantic cod - *Gadus morhua*

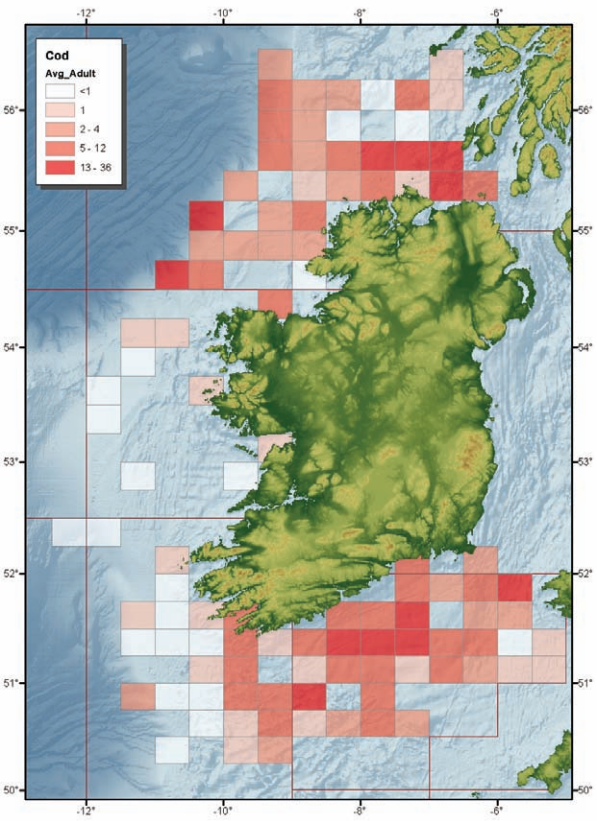
Biology – cod are fast growing and attain lengths in excess of 35cm in the first year and over 90cm as adults. About 50% of individuals are mature at 2 yrs and virtually 100% are mature by 3 yrs of age. Diet consists of benthic animals, crustaceans and small fish. Fish become more prevalent in the diet in older cod. Once mature an adult female can produce over 2 million eggs. Approximately 22% of the survey cod were below the minimum commercial landing size (MLS) and are an important source of independent information on the stock. However, low numbers of cod overall do limit the amount of juvenile data available from the survey.



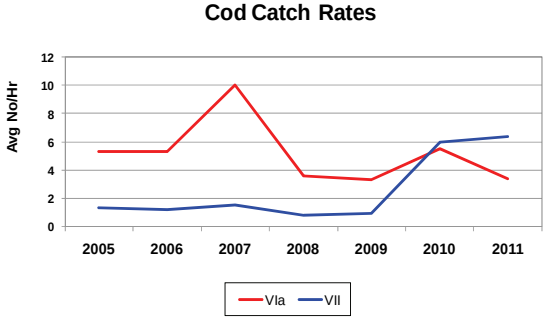


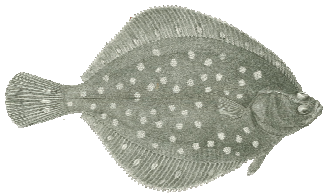
Distribution – Atlantic cod is widely distributed on both sides of the north Atlantic and from Norway to the Bay of Biscay. Cod on the survey are mostly caught as adult fish off the northwest coast and the Celtic Sea, at all survey depths.





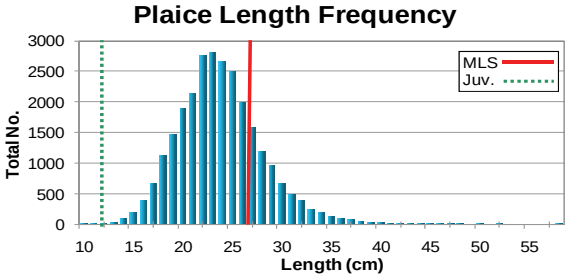
Catches – apart from a peak in 2007, survey catch rates to the northwest have remained low and stable between 2005-2011. In contrast there has been an increasing trend in the central Celtic Sea since 2008, although numbers overall remain low relative to other commercial gadoids.

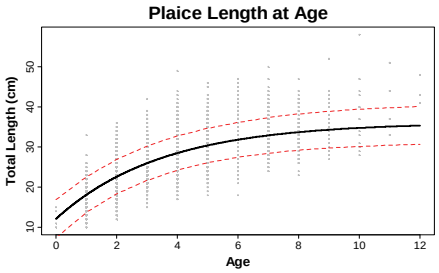




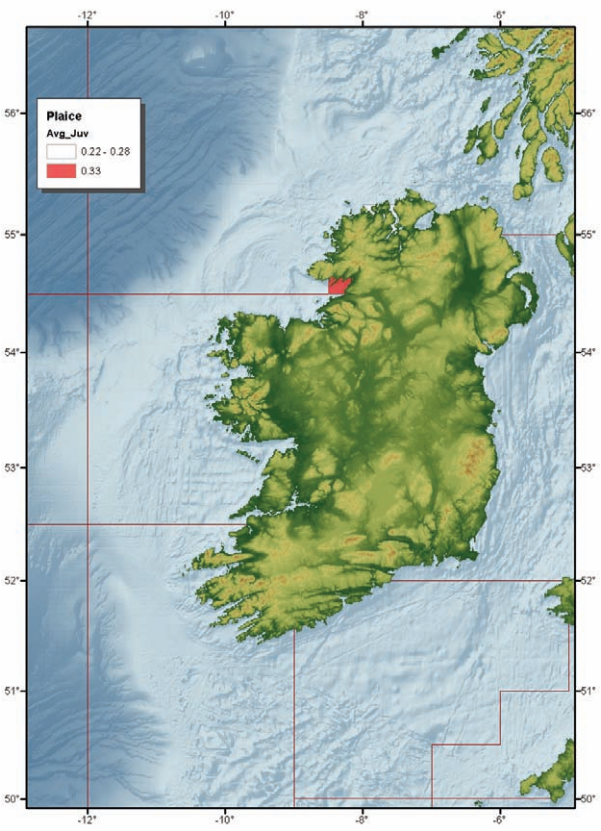
European Plaice - *Pleuronectes platessa*

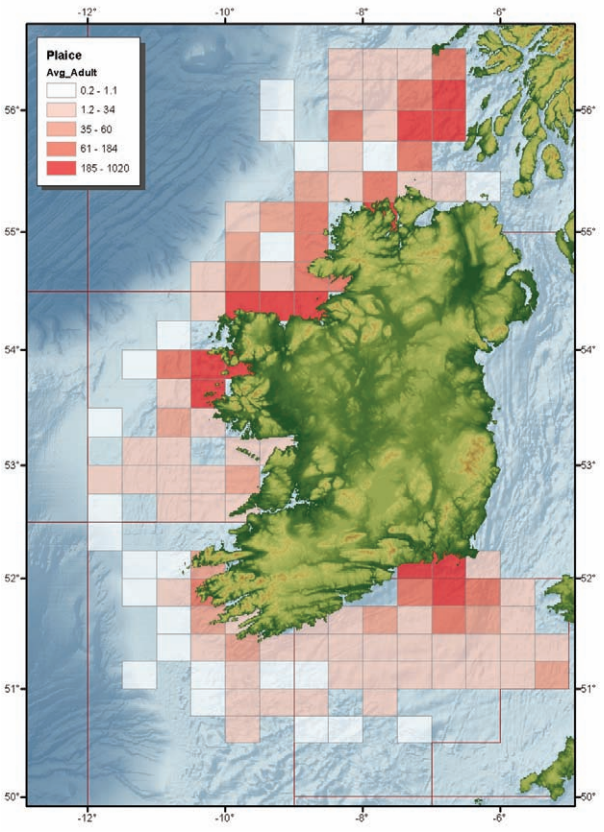
Biology – plaice are fast growing as juveniles, slowing down as energy is dedicated to reproductive growth. Females tend to grow larger and live longer than the males with a survey maximum length of 58cm compared to 39cm for males. The average length of plaice caught on the survey is 28cm. Juvenile plaice (< 1yr old) are not commonly caught on the survey, 77% of the survey plaice data is below the commercial Minimum Landing Size. About 50% are sexually mature by age 2 on the Autumn/Winter survey, this rises to about 90% by age 6 - 7. A 28cm mature female produces in the region of 60,000 eggs a year. Feeding is largely on small crustaceans, molluscs and worms.



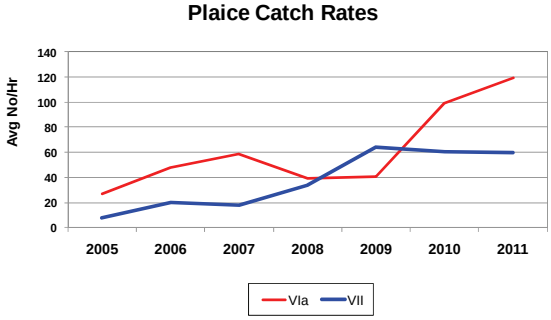


Distribution – plaice are distributed from southern Greenland to Norway, south to Morocco, and east to the Mediterranean and White Sea. Juveniles are very small (average length of 12cm) and found inshore in shallow water. Therefore they are not commonly encountered on the survey. Adults are have been caught over the survey area from10m down to 255m water depth, but on average they are caught between the coast and 120m depth especially over areas of sandy seabed.



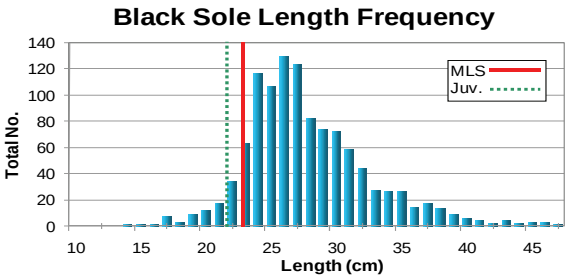


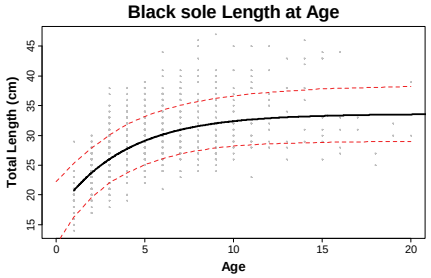
Catches – plaice catches have increased since 2005 in all survey areas, although more significantly in coastal areas to the northwest and the area off Waterford to the south. Commercially plaice are landed by otter & beam trawling. They are therefore a suitable species to sample via demersal trawl survey.



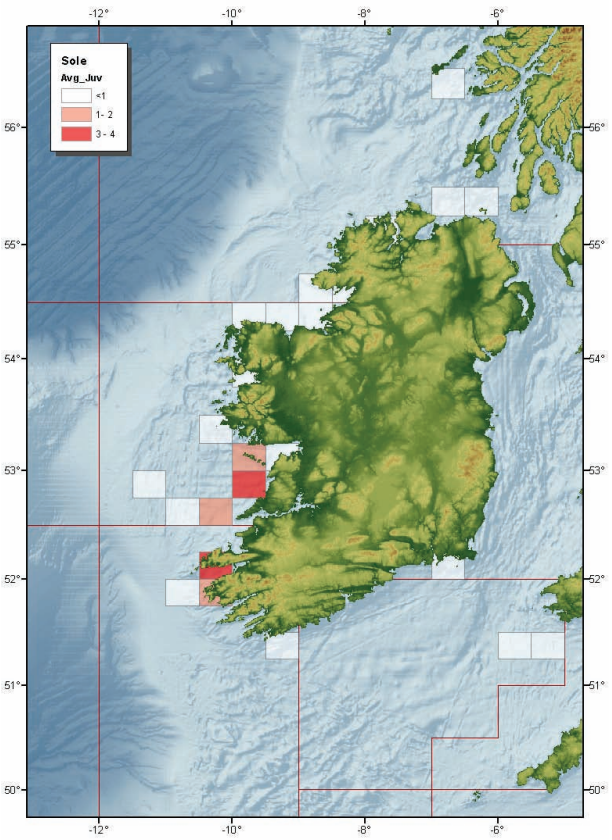
Black sole - *Solea solea*

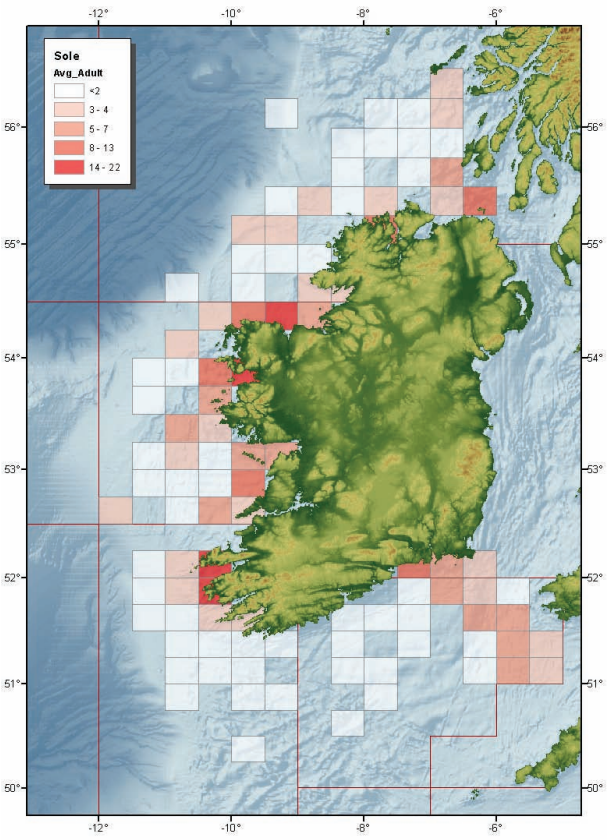
Biology – black sole (also called Dover sole) are flat fish which lie buried on sandy or muddy seabed. They feed primarily at night on small crustaceans, worms and bivalve molluscs. In common with many flatfish, sole are fast growing as juveniles, slowing down as they mature. Females grow larger than the males and maximum lengths from the survey are 47cm and 38cm respectively, with an average length of 28cm. Sole are quite solitary marine and estuarine fish, and the local environment may contribute to variable growth rates. Females reach maturity by ca. 6yrs and an average mature female can produce in the region of 150,000 – 200,000 eggs a year. Between 10 and 15% of the fish (by number) on the survey have been young fish below the commercial Minimum Landing Size (MLS).



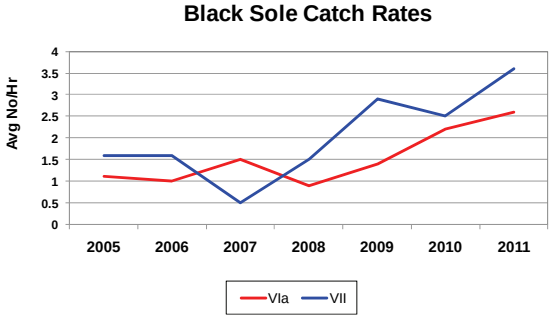


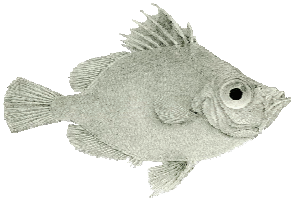
Distribution – black sole are found from Norway to west of Scotland in the north, down to Senegal in in the south, and east into the Mediterranean Sea. Adults have been mostly caught coastally around sandy bays and estuaries from 10m depth down to 255m on sandy habitat further offshore.





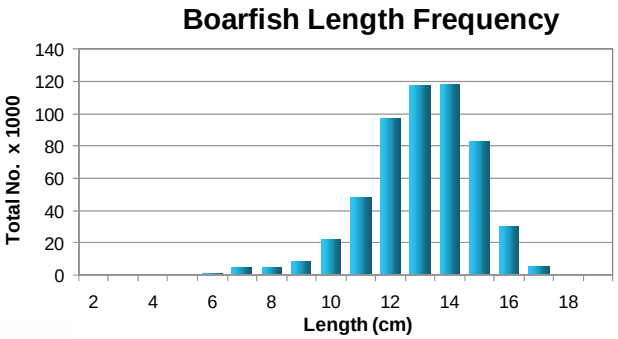
Catches – sole catches have increased steadily since 2007 off the west and south coasts, and since 2008 in the northwest. Like other flatfish, sole are generally landed by either otter trawling or beam trawling. While the method of surveying is similar to that used to harvest the species commercially, survey catch rates are generally low and therefore caution is needed when interpreting results.

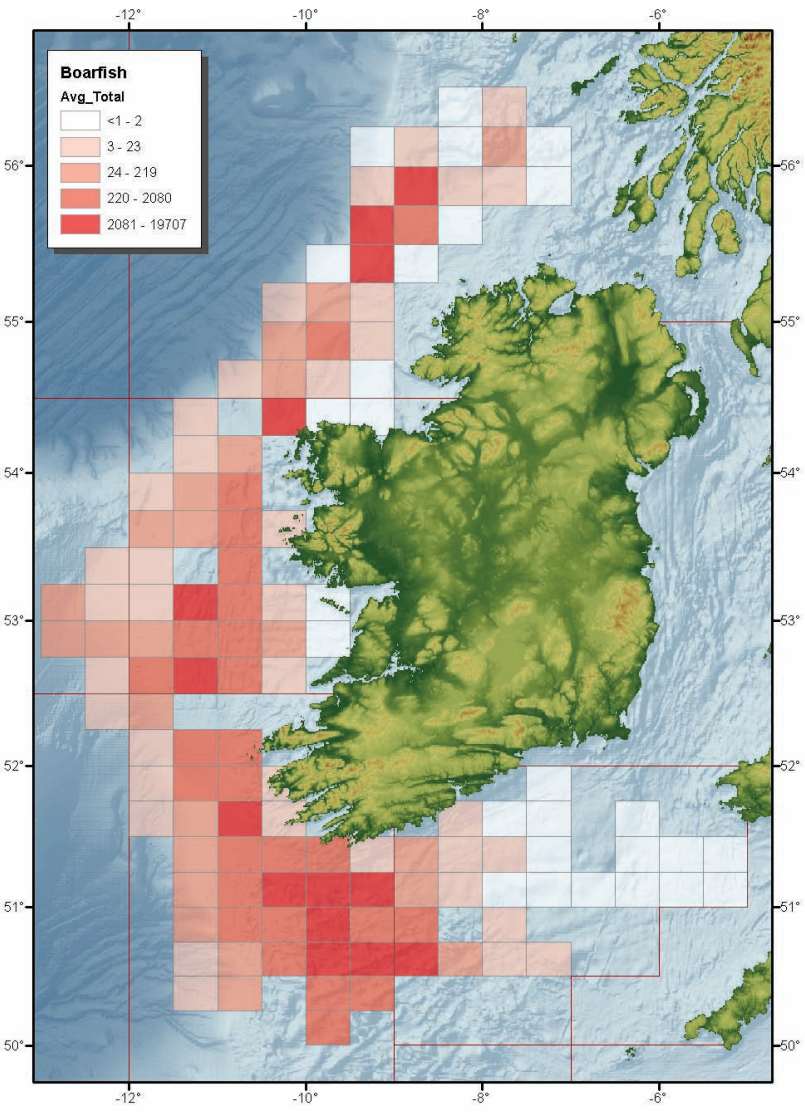




Boarfish - *Capros aper*

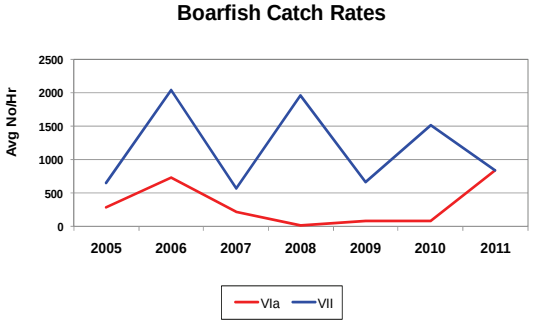
Biology – boarfish are deep bodied fish. They are a long lived species that can reach over 30 years of age. The mean length of boarfish caught on the IGFS is 10 cm with a maximum length of less than 20cm. The average length at maturity is approximately 9 cm which corresponds to an age of 3-4 years. Once mature, boarfish release eggs in batches during June and July. The diet of boarfish consists primarily of zooplankton especially copepods, but also mysids and euphausiids.

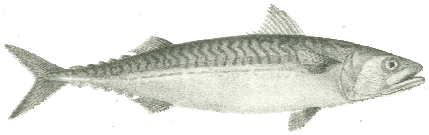




Distribution – boarfish is widely distributed and is found from Norway to Senegal, including the Mediterranean, Azores, Canaries, Madeira and Great Meteor Seamount. Although the stock definition is not well understood, it is assumed that boarfish caught on the groundfish survey belong to a stock that stretches from the Bay of Biscay to the North Sea. Boarfish is a pelagic shoaling species and they are widely distributed at depths from the surface to 600m. On the ground fish survey their average depth is ca. 150m but they have been recorded up to 750m deep.

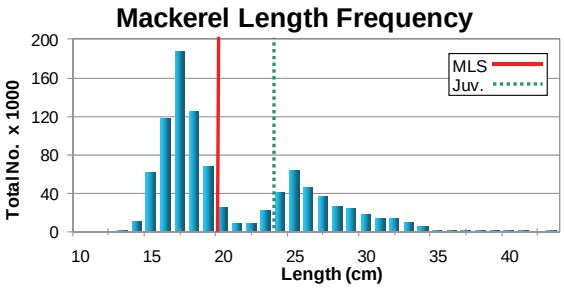
Catches – commercially, over 99% of boar fish are caught in pelagic trawls. Demersal trawling is not the most suitable sampling technique for this species and the shoaling nature of the species can result in occasional large hauls. However when data from several surveys are combined over a large area, catch rates provide a relative index of abundance that may be useful when assessing the state of the stock. On the Irish groundfish survey, most catches come from area VII, where values fluctuate considerably on an annual basis.

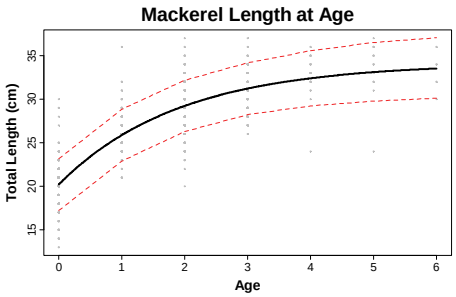




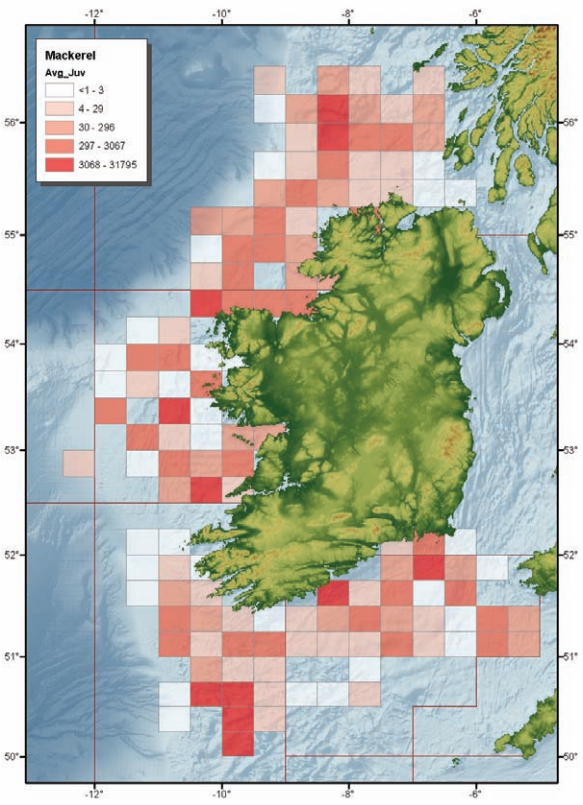
Mackerel - *Scomber scombrus*

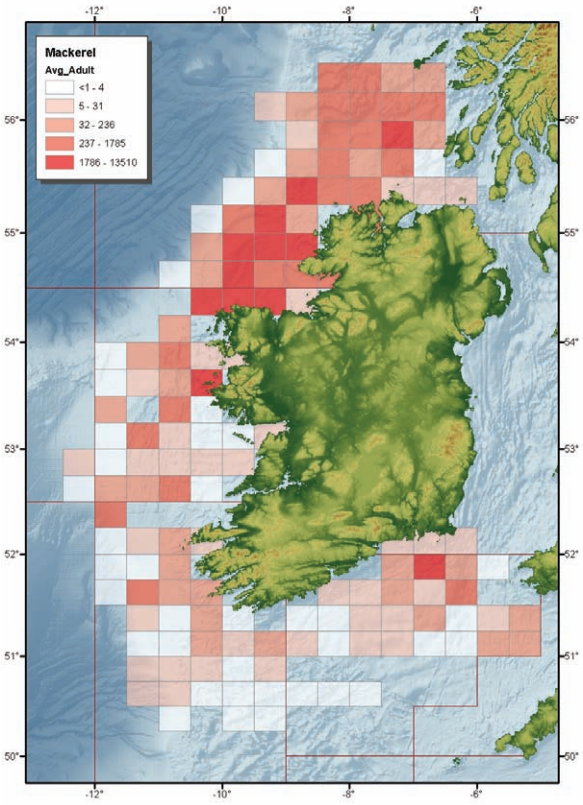
Biology – mackerel are relatively fast growing, and grow to over 20cm after the first year. The sizes caught on the IGFS survey range from 13cm to 43cm with a mean size of 26cm. This would correspond to a 1 year old fish. Mackerel feed mainly on zooplankton such as copepods and on small fish such as sandeel, sprat, small herring and Norway pout. They stop feeding almost completely during the winter. Mackerel mature relatively quickly with over 50% mature in their second year. Mackerel spawn in batches and release their eggs into the upper water column. A medium sized adult female produces ca. 500 000 eggs in a season.



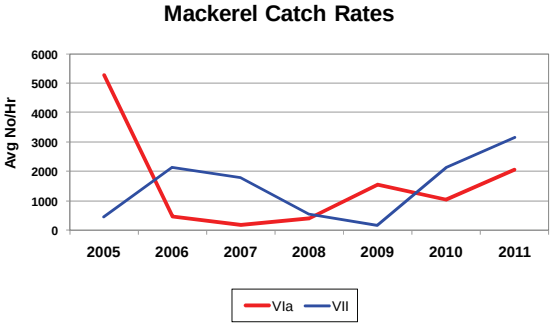


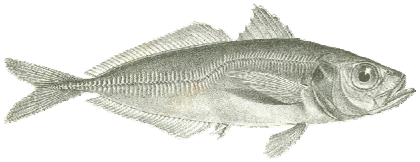
Distribution – the Northeast Atlantic mackerel stock is distributed between the Iberian Peninsula (south), the northern Norwegian Sea (north), Iceland (west) and the western Baltic (east) and is highly migratory. Mackerel form distinct shoals in midwater during their spawning migration but are more spread out and closer to the surface during feeding stages in the summer and in deeper waters during overwintering. Most mackerel caught on the groundfish survey are juveniles who can be found in equal proportions in coastal areas and on the shelf. The adult fish are mainly found on the north western shelf.





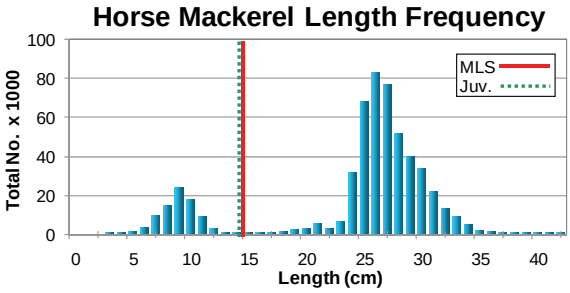
Catches – 99% of all commercial catches of mackerel are taken by pelagic gears. Due to their distribution in the water column and their shoaling behavior, demersal trawls are not the most suitable sampling gear to measure trends in mackerel abundance. Catches are very variable and the distribution can be very patchy, especially for juveniles. Thus, although the survey data can indicate the presence and absence of young and adult mackerel, they cannot be used to quantify abundance accurately.

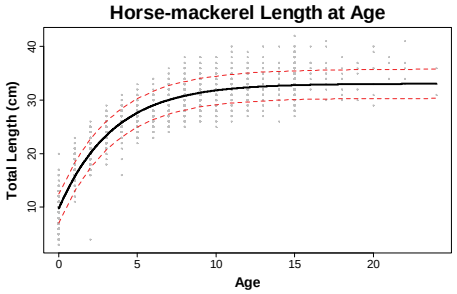




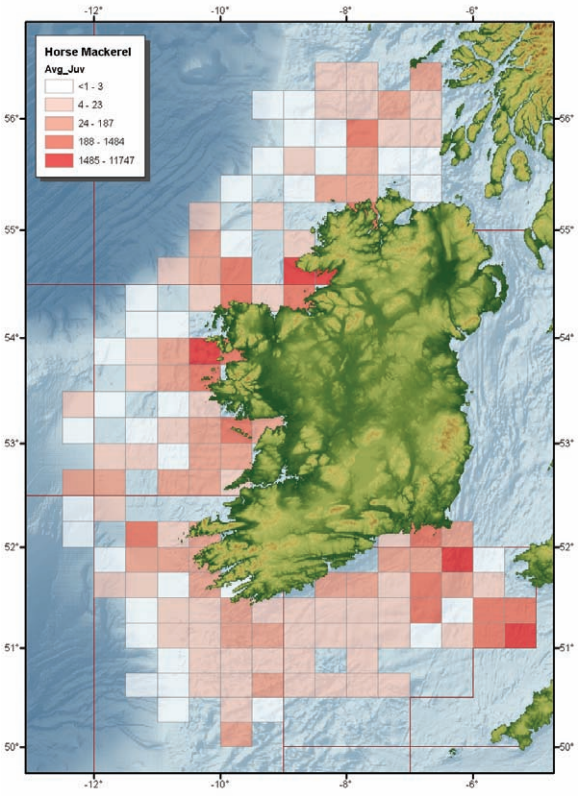
Horse Mackerel - *Trachurus trachurus*

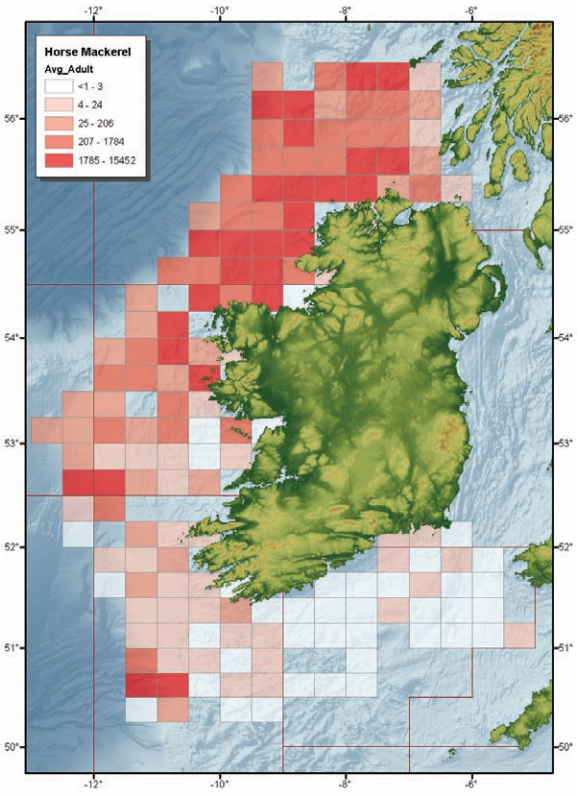
Biology – horse mackerel is a relatively long lived and slow growing species, reaching up to 40 years of age. Horse mackerel caught on the groundfish survey range from 3 cm to 43 cm with a mean size of 26cm, corresponding to 4 year old fish. Horse Mackerel are between 2 and 3 years old when they mature. Once mature, they produce and release several batches of eggs during each spawning season. Batches consist of approximately 50 000 eggs, depending on the size of the female. Horse Mackerel is primarily a filter feeder mainly ingesting zooplankton but also feeds on small fish such as juvenile whiting and herring.



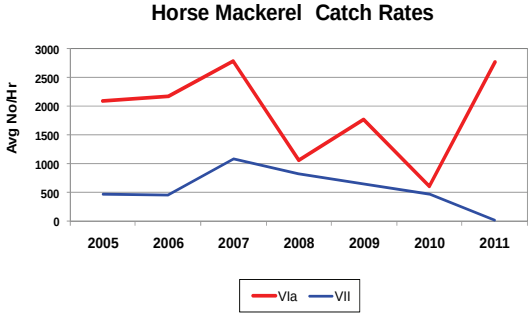


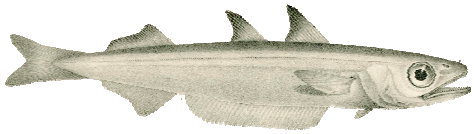
Distribution – horse mackerel caught on the Irish groundfish survey belong to the western horse mackerel stock, which is found along the European continental shelf between the Bay of Biscay and Norway. Horse mackerel is a pelagic species and can form dense shoals in mid to deep water. On the ground fish survey it is caught in depths of up to 750m but it has an average depth of 120m. Horse mackerel undergo extensive migration between spawning, feeding and overwintering grounds. The groundfish survey catches juveniles and as well as adults. The juveniles are mainly found in the inshore and coastal stations, while the adults are concentrated on the shelf, northwest of Ireland.





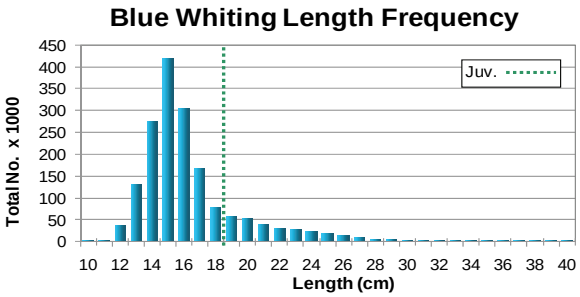
Catches – commercially, horse mackerel are mainly caught in pelagic trawls. However, its behaviour is closer to that of a demersal species and catches from a demersal trawl are likely to be more representative of the current stock status than for the other pelagic species. IGFS catches have decreased from a peak in 2007 although high catches rates were recorded in VIa in 2011.

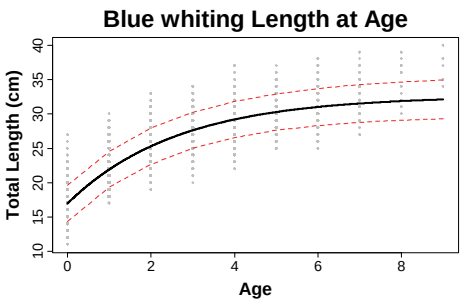




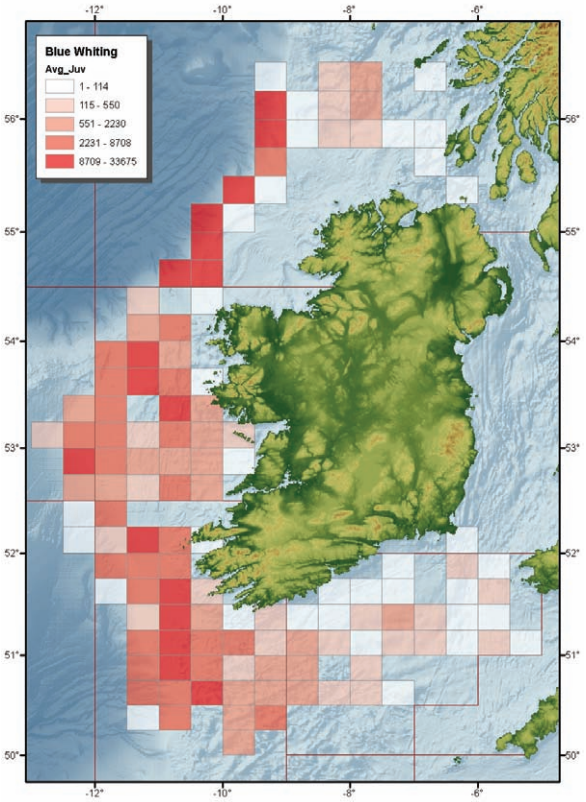
Blue Whiting - *Micromesistius poutassou*

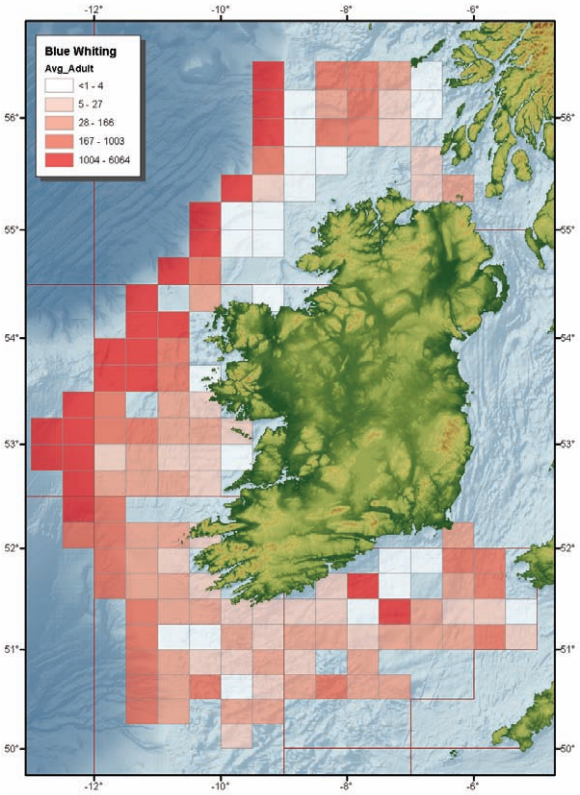
Biology – blue whiting is a relatively fast growing relation of cod. On the ground fish survey the size of specimen caught ranges between 10cm and 40cm with an average size of 20cm. This corresponds roughly to a 1 year old fish. Adults reach maturity between 2 - 7 years old and once mature they release their eggs into the water column in batches. Blue whiting consume zooplankton and small fish. They are an important prey species for larger fish and marine mammals.



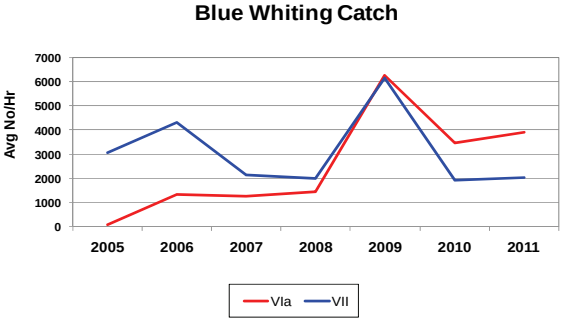


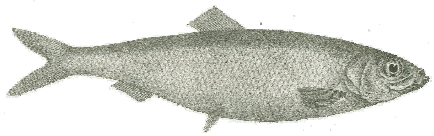
Distribution – blue whiting are widely distributed in the northeast Atlantic from the Barents and Norwegian seas in the north to the Iberian Peninsula in the south and are considered to be a single stock. Blue whiting are a pelagic species which can form dense shoals. They are highly migratory and undergo spawning, feeding and overwintering migrations. Although the groundfish survey catches both juvenile and adult fish, catches are dominated by the juveniles. Survey catches are concentrated along the continental shelf edge and the average depth for blue whiting on this survey is ca. 190m although they can be caught down to 750m.





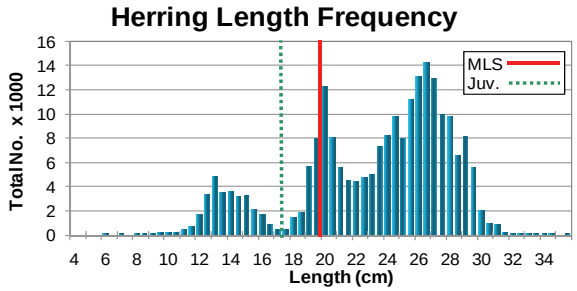
Catches – commercial blue whiting catches are by pelagic trawl. As blue whiting is a pelagic species, demersal trawls may not be the most suitable sampling gear to estimate their abundance. Catches can be very variable and are often dominated by a few large hauls. However, by combining the data from several ground fish surveys along their distribution area, important ancillary information on the arrival of juveniles is available.

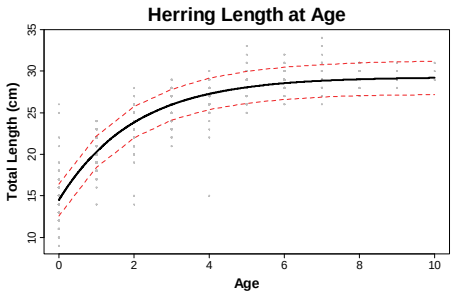




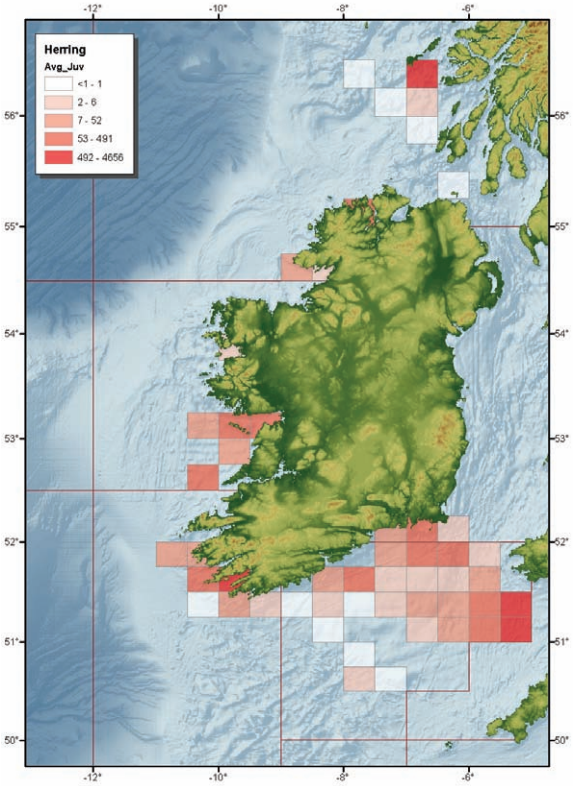
Herring - *Clupea harengus*

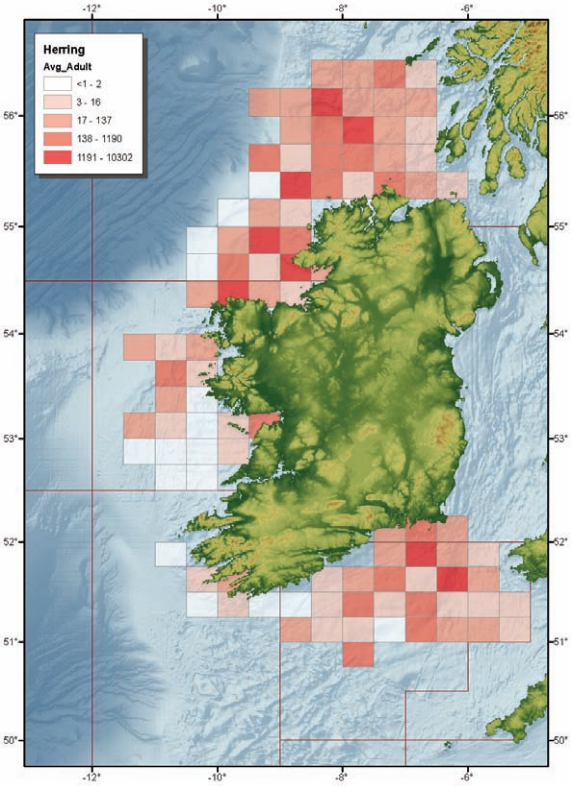
Biology – herring are a fast growing and early maturing species. They can reach 20cm in size in their first to second year, but then growth levels off very quickly and they rarely reach sizes over 37cm. The mean size of herring caught on the ground fish survey is 22cm, which corresponds to fish in their second to third year. Half of herring are mature in their second year and all are mature in their third year. Herring are benthic spawners, which means they deposit their eggs on the sea floor, in particular on gravel beds. Herring feed primarily on copepods, and they are an important prey species for larger fish such as hake.



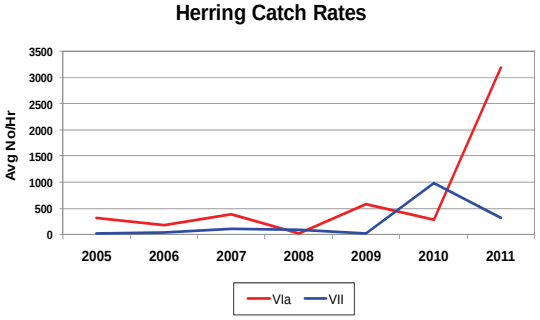


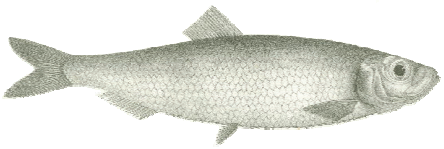
Distribution – herring is widely distributed on both sides of the North Atlantic. The Celtic Sea is the southern limit of its distribution in the eastern Atlantic. Herring are a pelagic shoaling species that undergo migrations between spawning, feeding and overwintering grounds. The adults caught on the groundfish survey are distributed northwest of Ireland and in the eastern Celtic Sea. Juveniles are only found in the Celtic Sea and to the west of Ireland close to the coast. The average depth distribution of herring on the groundfish survey is around 80m but they have been recorded in water depths of up to 255m.





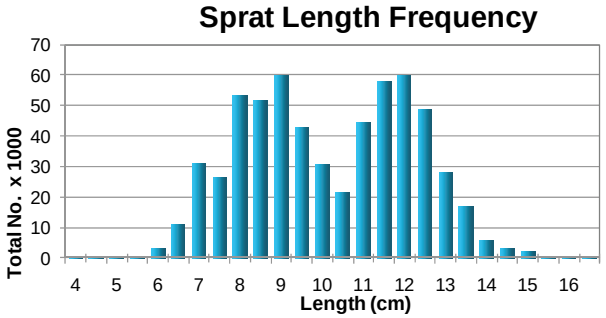
Catches – commercially, herring are caught by pelagic trawl. Demersal survey gear has limited suitability to sample this species. Catches are variable and herring are either caught in high aggregations or not all. However, the survey can provide important qualitative information on herring and can indicate if there are particularly weak or strong year classes coming through. This can be seen in the time series of catch rates which shows very high abundance of herring in VIa in 2011. This is considered to indicate recent improved recruitment in VIa.

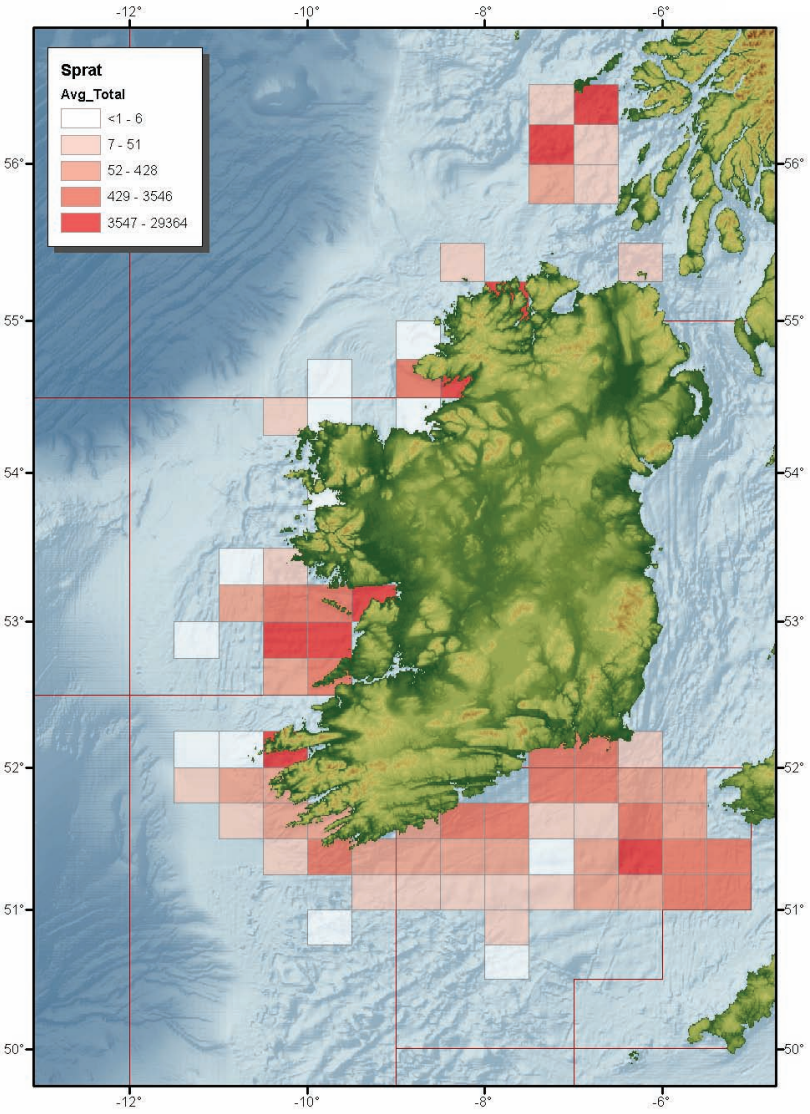




Sprat - *Sprattus sprattus*

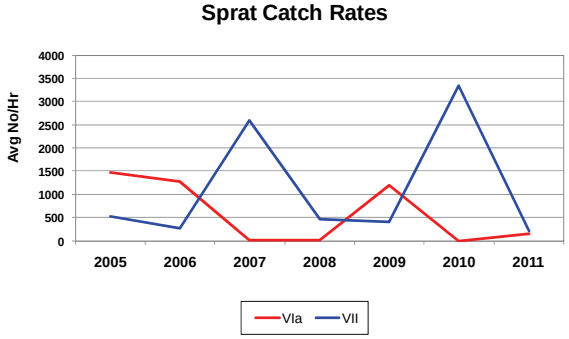
Biology – sprat are a short lived, fast growing species. The size range caught on the survey is between 3cm and 17cm with a mean size of 9cm. Sprat reach maturity in their first to second year and most live to about four years. Sprat feed on plankton and are an important prey fish for several fish species as well as sea birds and marine mammals.





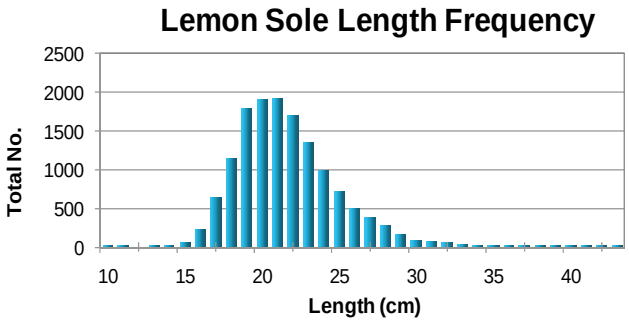
Distribution – sprat are a pelagic shoaling species, which are distributed in shallow waters in the Bay of Biscay, the Celtic Seas, the North Sea and the Baltic Sea. It is not known whether sprat in the Celtic Sea constitute a discrete stock. On the groundfish survey sprat are primarily found at the inshore stations and in bays at depths ranging from 10m to 180 m. They are also found in some concentrated patches in the eastern Celtic Sea and to the west of Scotland.

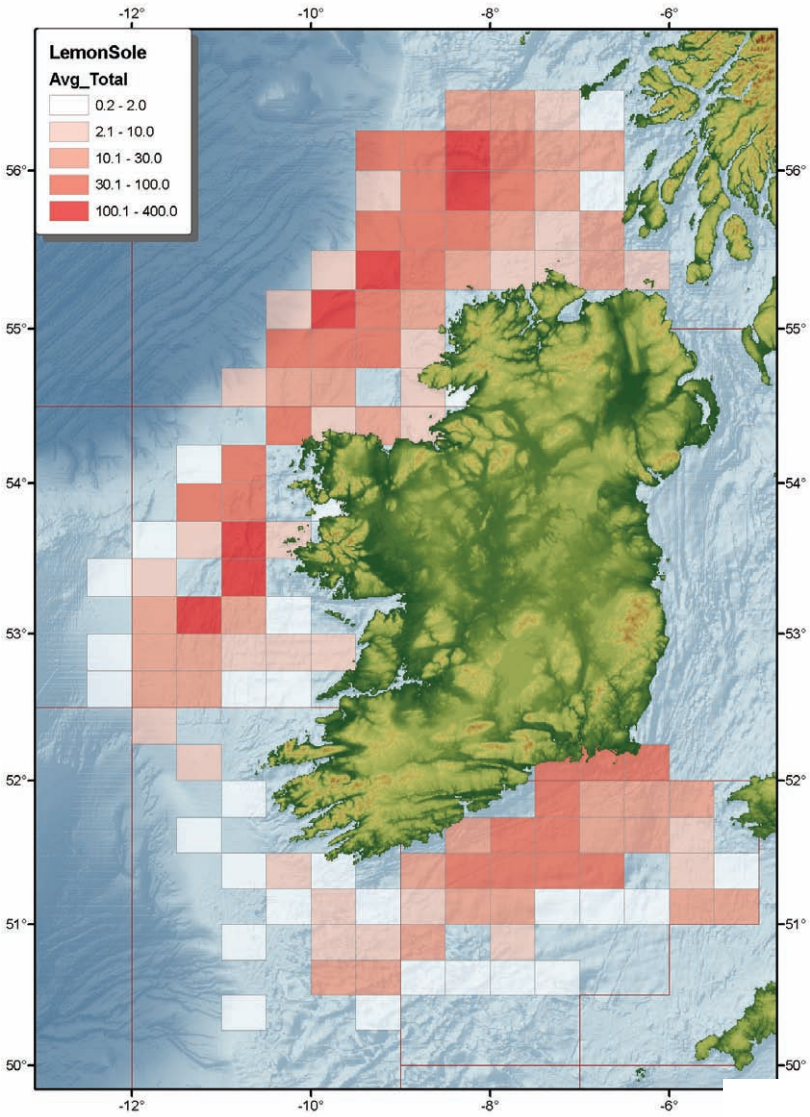
Catches – commercial fisheries on sprat are carried out by pelagic trawl. Catches sampled by demersal trawl on the IGFS are highly variable and are often dominated by a few large hauls. This can be seen in the time series of catch rates which shows large variability of sprat in VIa and VII. Thus, the IGFS has limited potential in providing estimates of sprat abundance. Studies in the North Sea have shown that using a combination of different surveys at different times of the year improves the confidence in giving useful information on sprat abundance by bottom trawl surveys (ICES, 2011HAWG).



Lemon sole - *Microstomus kitt*

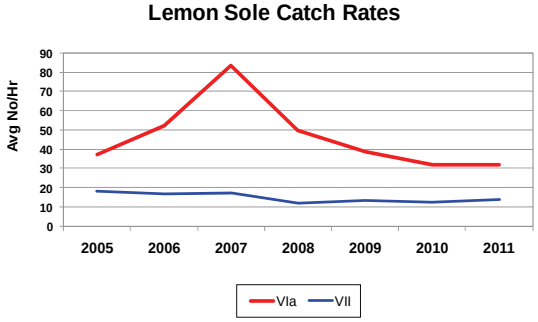
Biology – lemon sole are members of the plaice family (not true sole) and have been caught on the survey from 10cm in length (10g) to 43cm which is almost one kg in weight. Females grow larger than males with the max length of each being 43cm and 35cm respectively. Although lemon sole from the survey are not aged, they are reported to reach a maximum size of 65cm and live up to 20 years. Males mature at 3 - 4 years and females at 4 - 6 years. Lemon sole have tiny mouths and feed primarily on polychaetes, but also a variety of small invertebrates. Apparently lemon sole do not feed during the winter months.

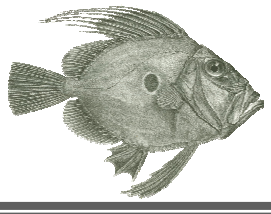




Distribution – lemon sole are found from the southern Bay of Biscay to the White Sea northeast of Norway and west to the shores of Iceland. Associated with stony bottoms, they are caught on the survey most commonly off the west and northwest coasts, with lesser catches occurring in the northern Celtic Sea. Catch distribution has been from 22m to moderately deep water at 292m, with an average of 112m.

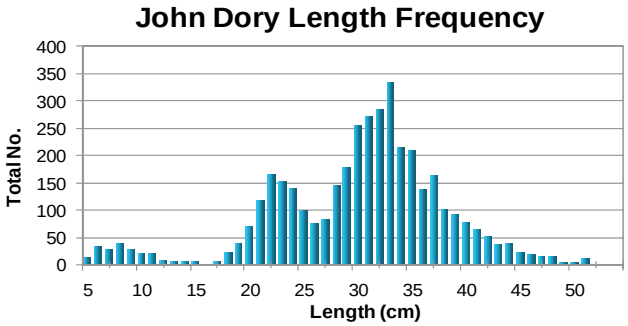
Catches – lemon sole catches in the northeast increased from 2006, peaked in 2007 and thereafter dropped to historic low levels in the region of 40 fish per hour. To the west and in the Celtic Sea catches have been quite consistent between 10 and 20 individuals per hour, half the recent catch rates off Donegal and west of Scotland. Lemon sole are largely harvested commercially by towed otter and beam trawls, with a smaller, but also significant proportion landed by seining.

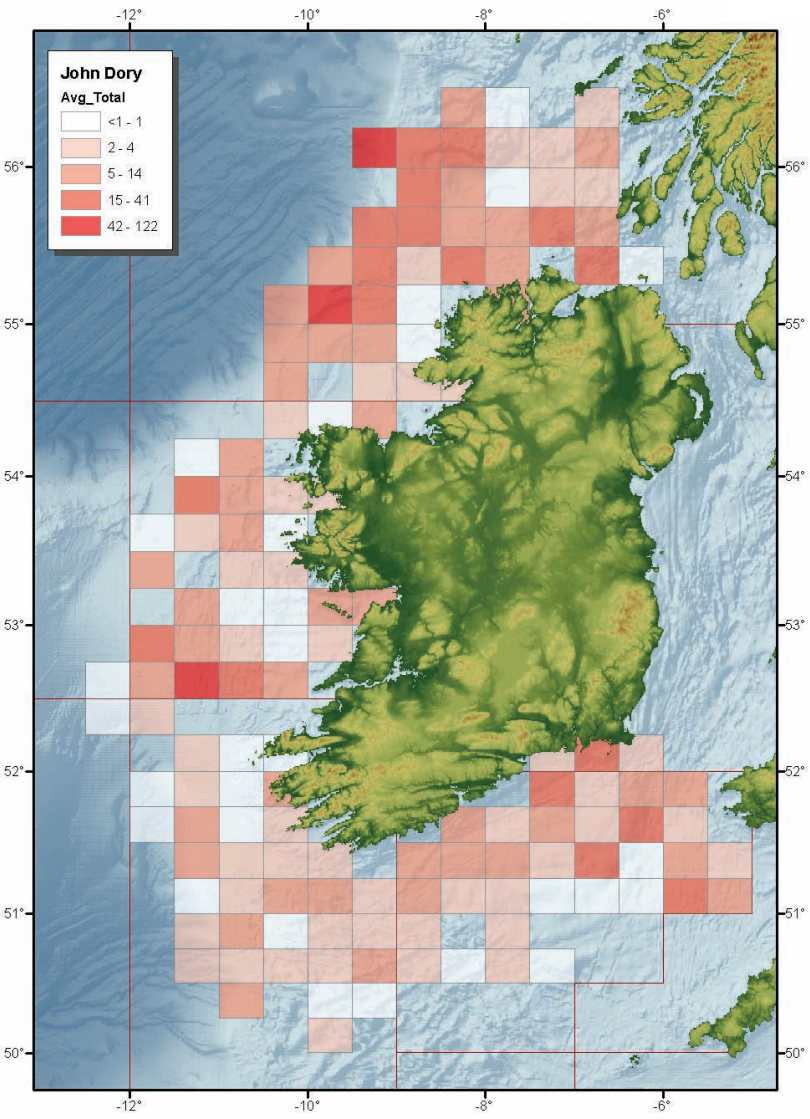




John Dory - *Zeus faber*

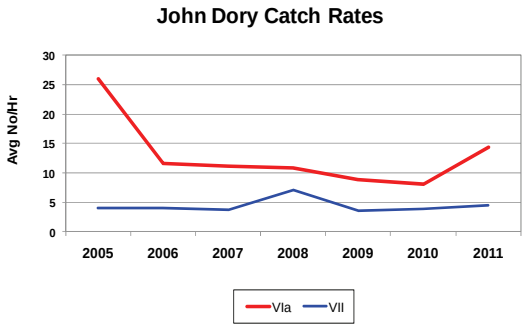
Biology – John Dory can reach lengths in excess of 60cm and can live for up to 12 years. Maturity is reached at 3 - 4 years, at about 25 - 28cm for males and 34 - 38cm for females. It feeds largely on fish but also consumes cephalopods and crustaceans. John Dory is generally a solitary fish and rarely forms shoals larger than 5 individuals. The size range of John Dory caught on the survey is 3cm to 54cm with an average size of 28cm.

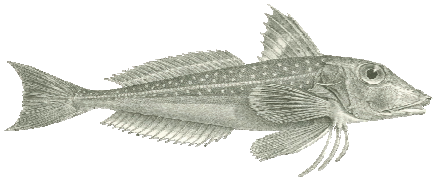




Distribution – John Dory is widely distributed in the north Atlantic, from Norway to South Africa and also the Mediterranean and Black Sea. It has been caught on the survey at depths from 11m to 419 m but is most common at depths less than 160m. It has been caught in small numbers throughout the survey area but has been most abundant off the northwest.

Catches – Survey catches in the northwest showed a large decline in 2006 and remained fairly constant until 2011 when an increase was observed. Catches to the west of Ireland and in the Celtic Sea, while lower than in the northwest have remained stable with a slight peak in 2008. Commercially, John Dory are generally landed as bycatch by demersal otter trawls with a small amount also landed by beam trawls and seining.

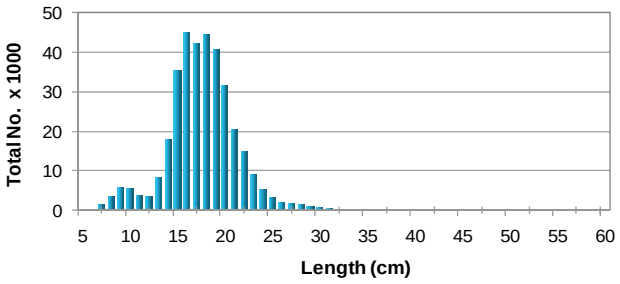


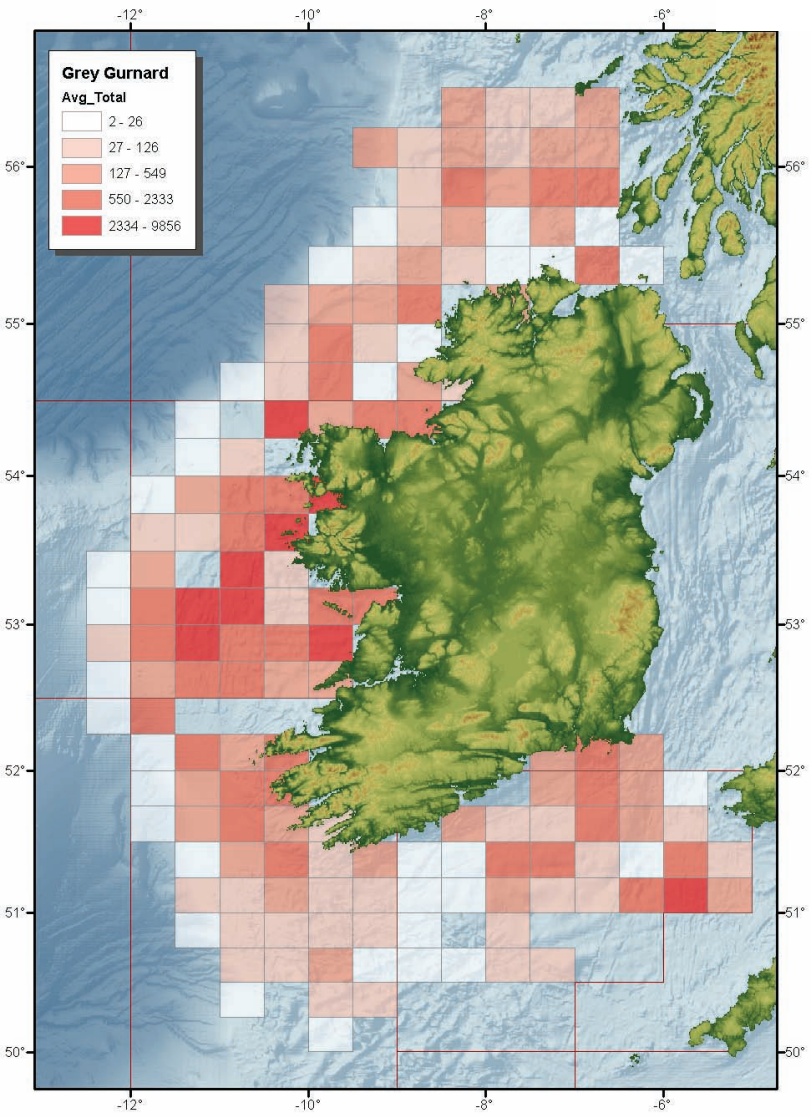


Grey Gurnard - *Eutrigla gurnardus*

Biology – grey gurnard reach a maximum length of 60cm but are commonly less than 30cm. The size range of grey gurnard caught on the survey has been 3-58cm with an average size of 20cm. It feeds mainly on crustaceans and fish.

Grey Gurnard Length Frequency

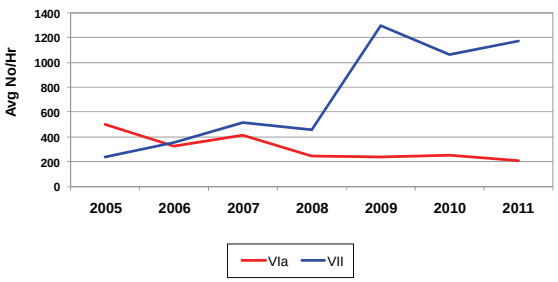


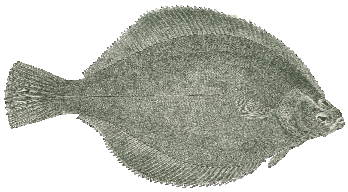


Distribution – grey gurnard occurs in the eastern Atlantic from Iceland, Norway, southern Baltic, and North Sea to southern Morocco, and Madeira Islands. It is also found in the Mediterranean and Black Seas. It is common on sandy grounds between the coastline and 140m depth but also on rocky and muddy seabeds. Grey gurnard have been caught throughout the survey area but in largest numbers off the west coast. The species been caught at depths up to 750m but generally at an average of 120m.

Catches – survey catches of grey gurnard in the southern and western areas have increased over the survey time period with the largest increase in 2009. In contrast, the northwest catches declined from 2005 to 2008 and have remained relatively stable since 2008 at approximately 250 individuals, which is about 20% of the recent catch rates in the western and southern areas.

Grey Gurnard Catch Rates

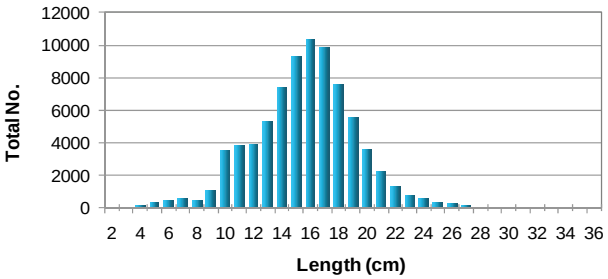


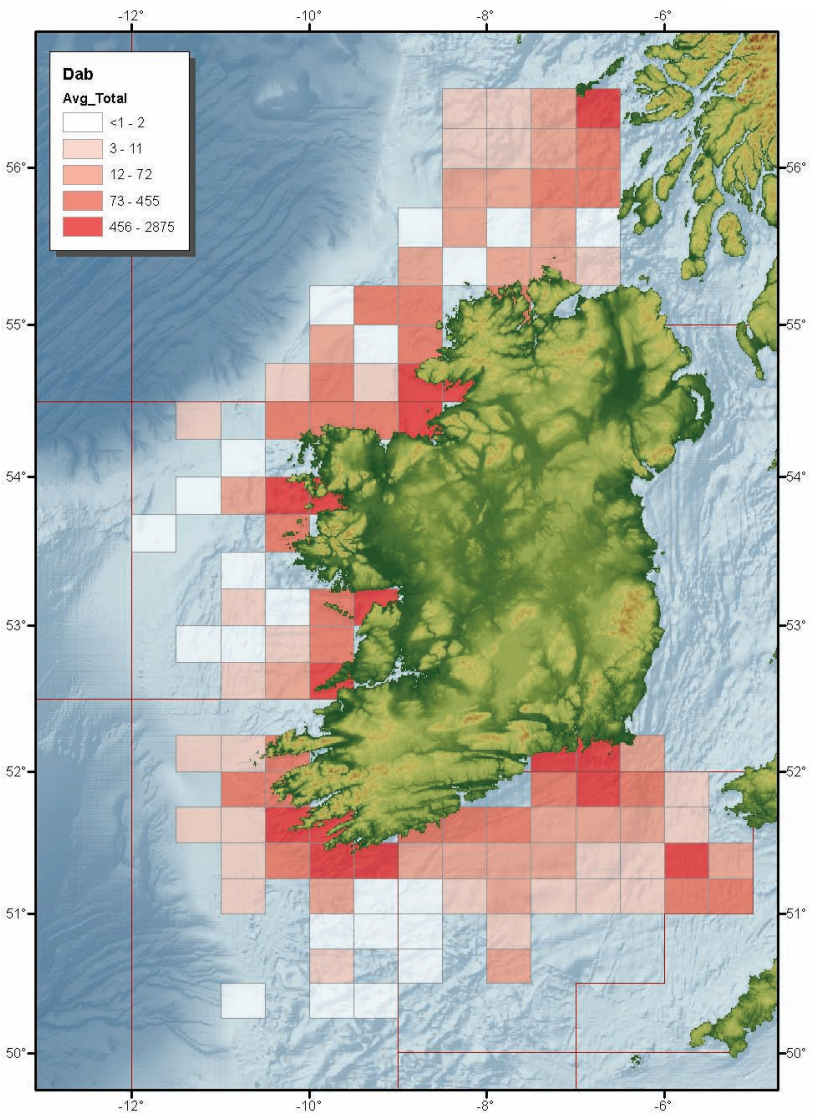


Dab - *Limanda limanda*

Biology – dab are similar in appearance to plaice but have a distinctive curve in the lateral line above the pectoral fin. The sizes caught on the survey range from 3cm to 36cm with an average of 18cm. Dab are not aged on the survey but can live up to 12 years. They are batch spawners and reach first maturity between 13 and 25cm, at around 2 years of age. Spawning occurs during the spring with a 30cm female producing up to a million eggs. Feeding is mainly on crustaceans and small fishes.

Dab Length Frequency

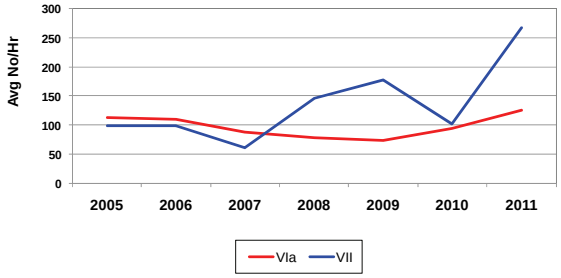


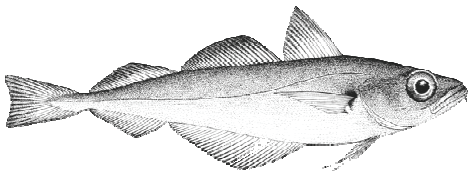


Distribution – dab is widely distributed in the north Atlantic from the White Sea to Biscay, around Iceland and in the west Baltic Sea. It migrates seasonally from inshore in the spring and summer to further offshore in the autumn and is usually associated with sandy seabeds. Dab were found throughout the survey area from 10m – 324m but generally <100m.

Catches – survey catches have remained quite constant overall in area VIa to the northwest of Ireland. In the west and south, catch rates have oscillated, but an overall increasing trend can be clearly seen.

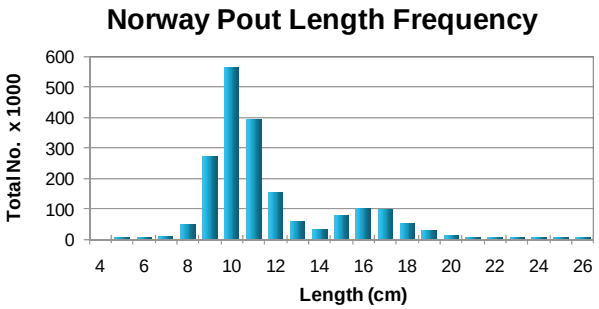
Dab Catch Rates

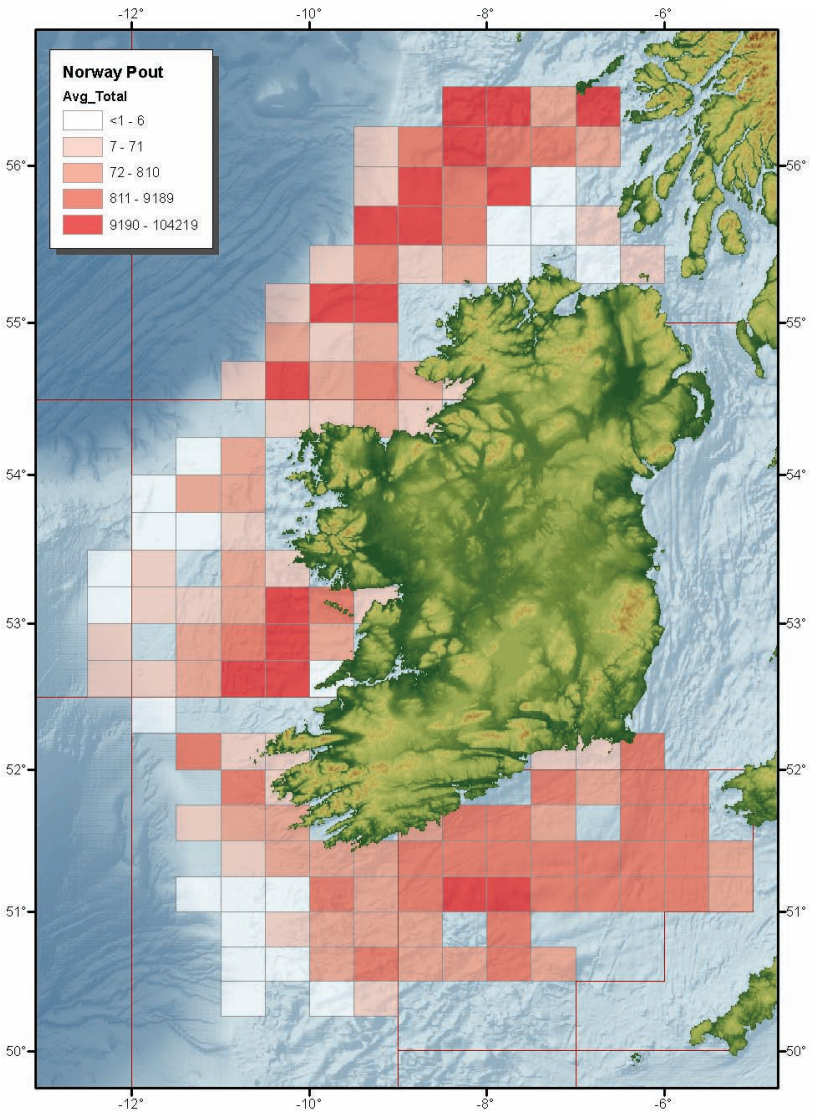




Norway pout - *Trisopterus esmarki*

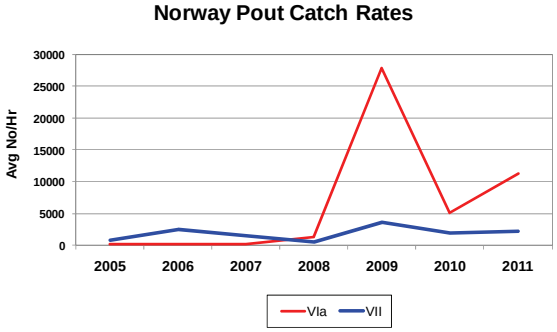
Biology – Norway pout are fast growing but only reach a small maximum size. The size range caught on the survey has been between 5cm - 26 cm with an average of 13cm. Maximum age is 4 - 5 years and maturity is reached at 2 years of age (11-15cm). A 15 -19cm fish lays 27,000 – 51,200 eggs and the spawning season extends from January to July. It feeds mostly on planktonic crustaceans but also on small fish and various eggs and larvae. Norway pout is an important prey item for many predatory fish species.

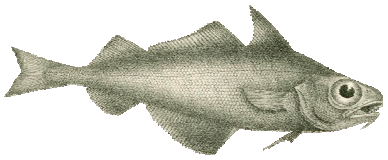




Distribution – Norway pout is found west to Iceland and north to Bear Island in the Barents Sea. Its southern extent reaches to the bay of Biscay. It lives close to or above muddy seabed and has been caught throughout the survey area at depths from 21m to 380m. It is most abundant close to the shelf edge off the northwest coast. Norway pout is often encountered in dense aggregations of mixed small gadoids also including blue whiting (*Micromesistius poutassou*) and juvenile whiting (*Merlangius merlangus*).

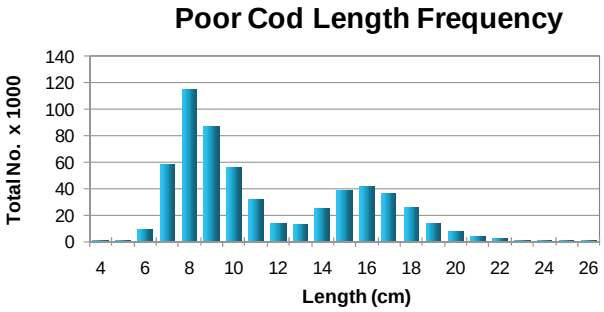
Catches – survey catches in 2009 showed an extreme peak in the northwest VIa area, with a smaller peak in 2011. This increase was well in excess of the increased catches observed in the west and southern areas of the survey in the same year.

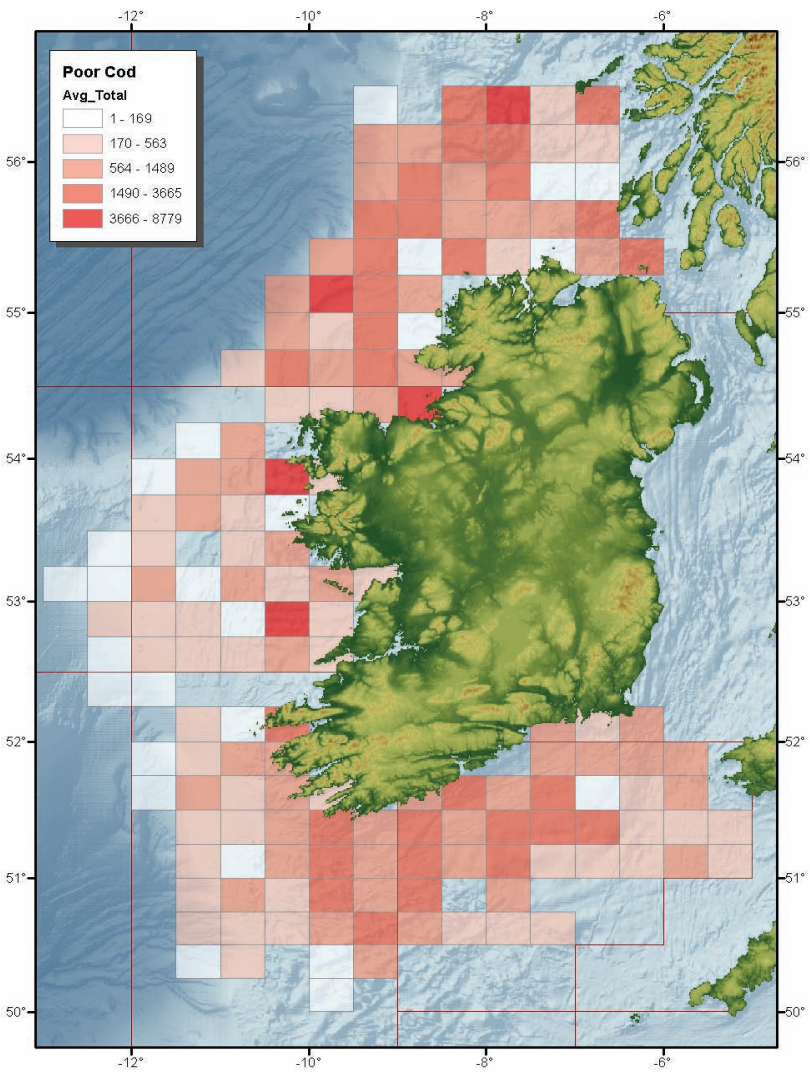




Poor cod - *Trisopterus minutus*

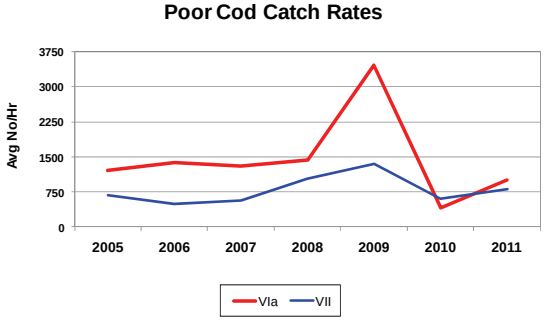
Biology – poor cod are small gadoids found commonly throughout the survey. Females grow larger and live longer than the males. The maximum age of poor cod is 5 years and maturity is reached after 1 year. The spawning season extends from December to March. It feeds mostly on crustaceans, small fish and polychaetes. Poor cod is an important prey item for many predatory fish species.

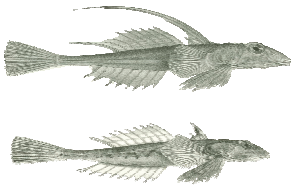




Distribution – poor cod is widely distributed in the north Atlantic from Norway to the coast of Morocco and in the Mediterranean. It is benthopelagic to depths of 400m but is mostly found from 15 to 200m. Poor cod have been caught throughout the survey area, from 10-517m but at an average depth of 120m.

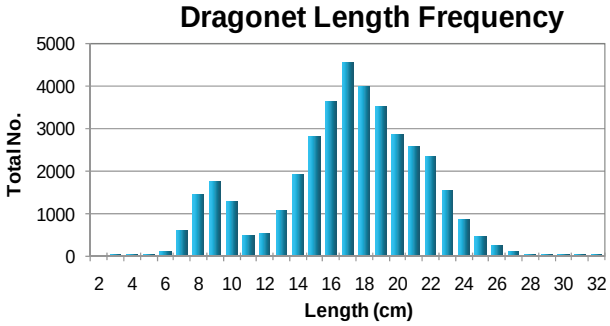
Catches – as seen with Norway pout survey catches of poor cod in 2009 showed a large peak in Via . However this was followed by a drop to a historic low in 2010 before increasing slightly in 2011. Catches in the west and southern areas increased from 2007-2009 but decreased again in 2010.

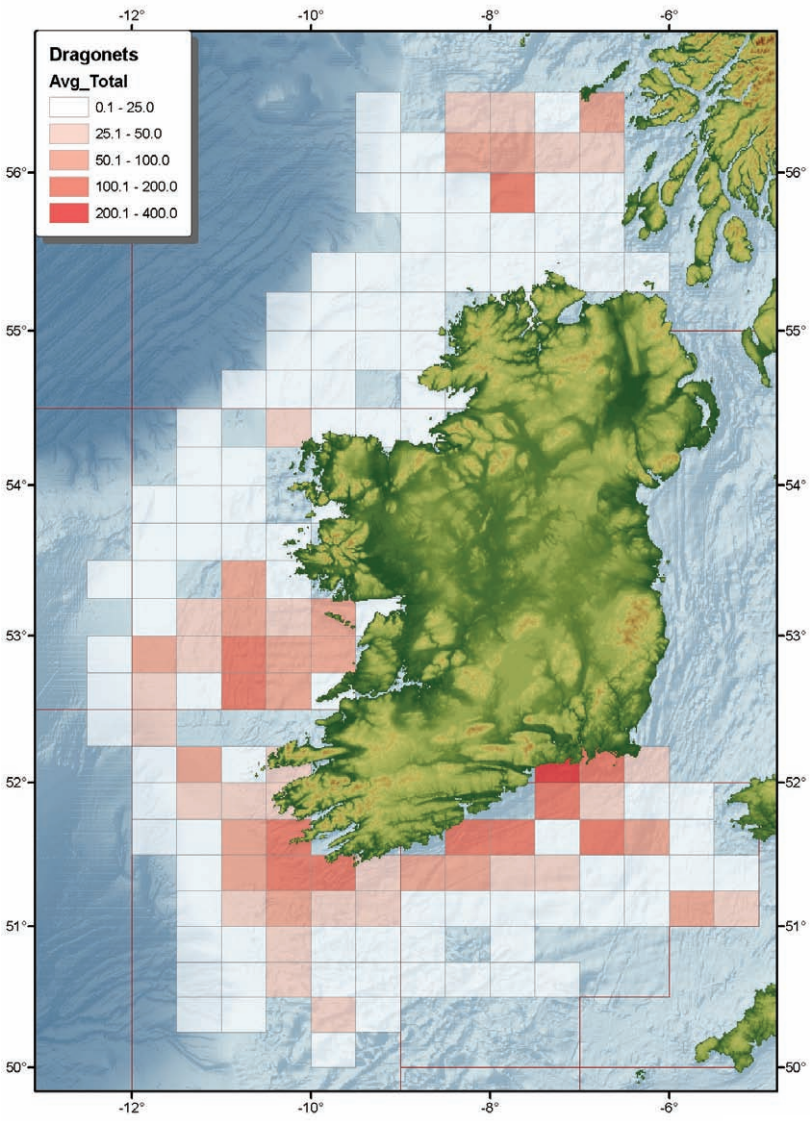




Dragonet - *Callionymus spp.*

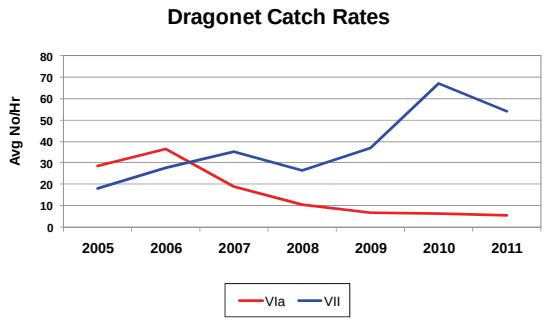
Biology – there are two main species of dragonet caught on the survey - common dragonet *Callionymus lyra* and spotted dragonet *Callionymus maculatus*. Common dragonet is the larger of the two species, reaching sizes in excess of 30cm where as spotted dragonets are usually less than 16cm in length. Both species exhibit sexual dimorphism with sexually mature males being much brighter in colour and having larger dorsal fins than female and immature fish (this can be seen in the plate above of *C. lyra* with the male on top). Dragonets feed on small invertebrates such as worms, snails and crustaceans.

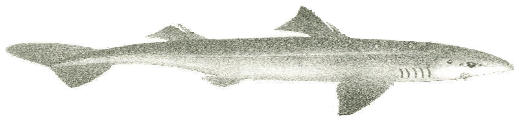




Distribution – from southern Iceland and Norway south to Mauritania, including the northern Mediterranean, Gibraltar and Algeria. Common dragonet is found in shallow water, usually 50m or less but occasionally to 100m. Spotted dragonet, while less frequently encountered, can be found to depths up to 600m. Dragonets have been caught over the whole survey area from depths of 10m-520m of depth with the largest catches to the west and in the Celtic Sea.

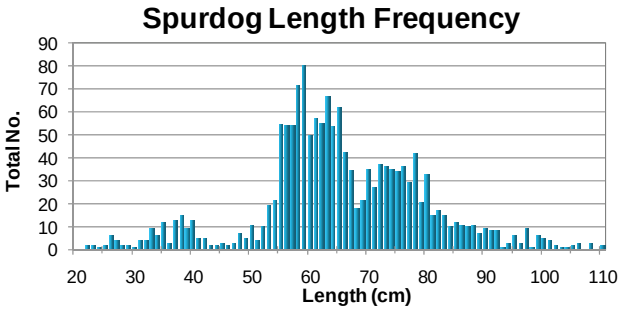
Catches – survey catches of dragonet off the west and south coasts (VII) have increased steadily to a peak in 2010 before declining slightly in 2011. In contrast catches in the northwest (VIa) have declined since 2006 to a historic low of approx. 6 fish per hour in 2011, much lower than the catch rates off the west and south.

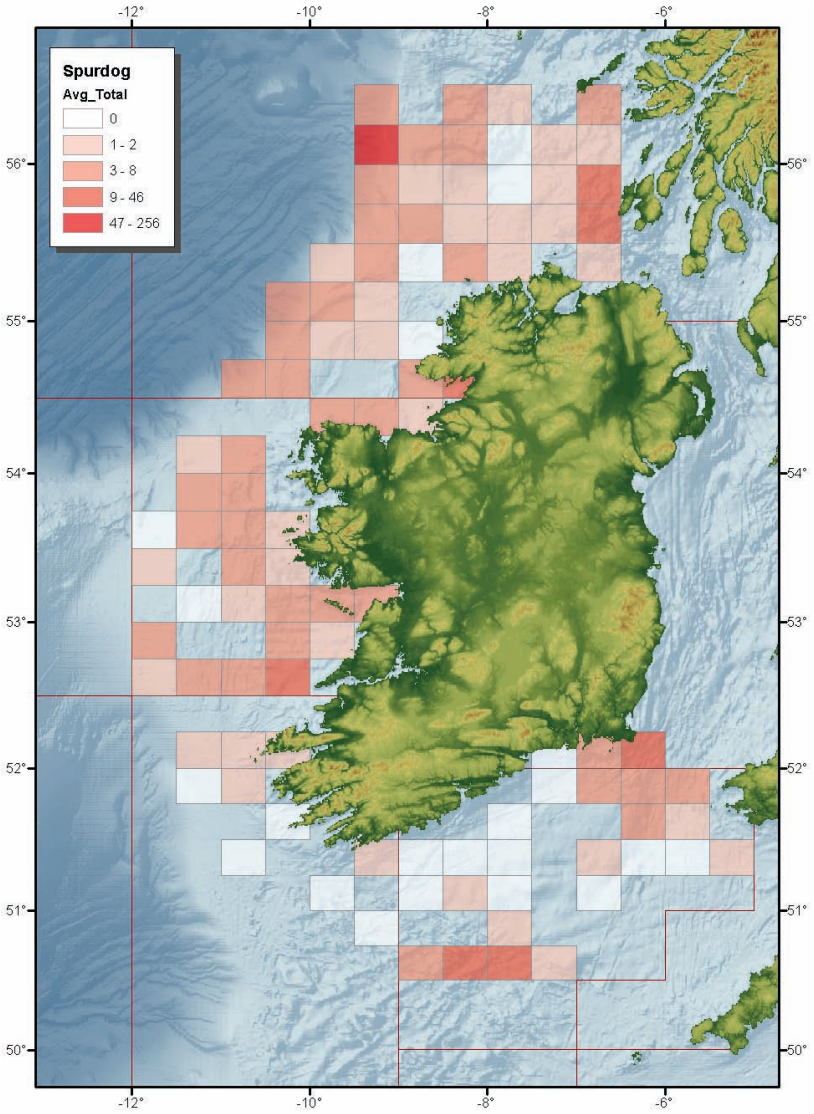




Spurdog - *Squalus acanthias*

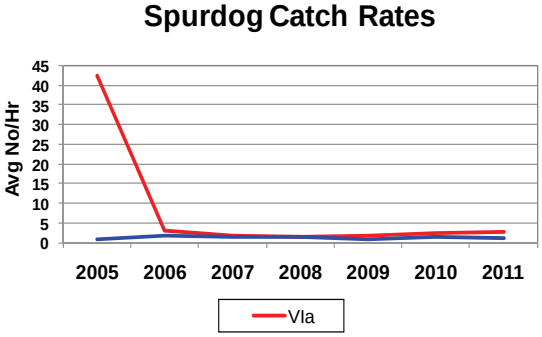
Biology – spurdog are a long lived, slow growing and late maturing species. They are therefore particularly vulnerable to fishing mortality. Spurdog caught on the survey range from 22cm to 114cm with an average of 69cm. Spurdog give birth to live young. The average litter is 9 pups. Feeding is largely on fish but they also eat crustaceans, cephalopods and worms.





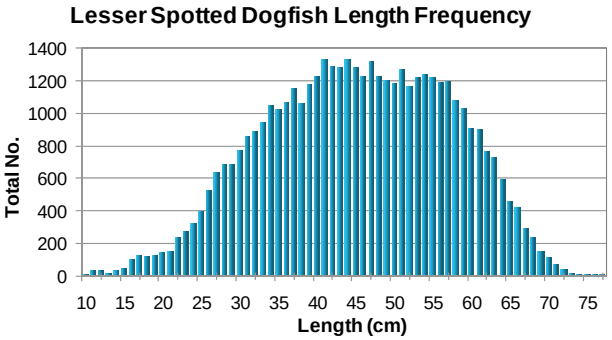
Distribution – spurdog are widely distributed in the north Atlantic from Greenland to Argentina in the west and from Russia to the Canary islands in the east. They can also be found off South Africa, in the Pacific and off southern Australia and New Zealand. They can be found from intertidal areas down to 900m. On the groundfish survey spurdog are mostly caught off the west and northwest coast at depths from 28m to 310m.

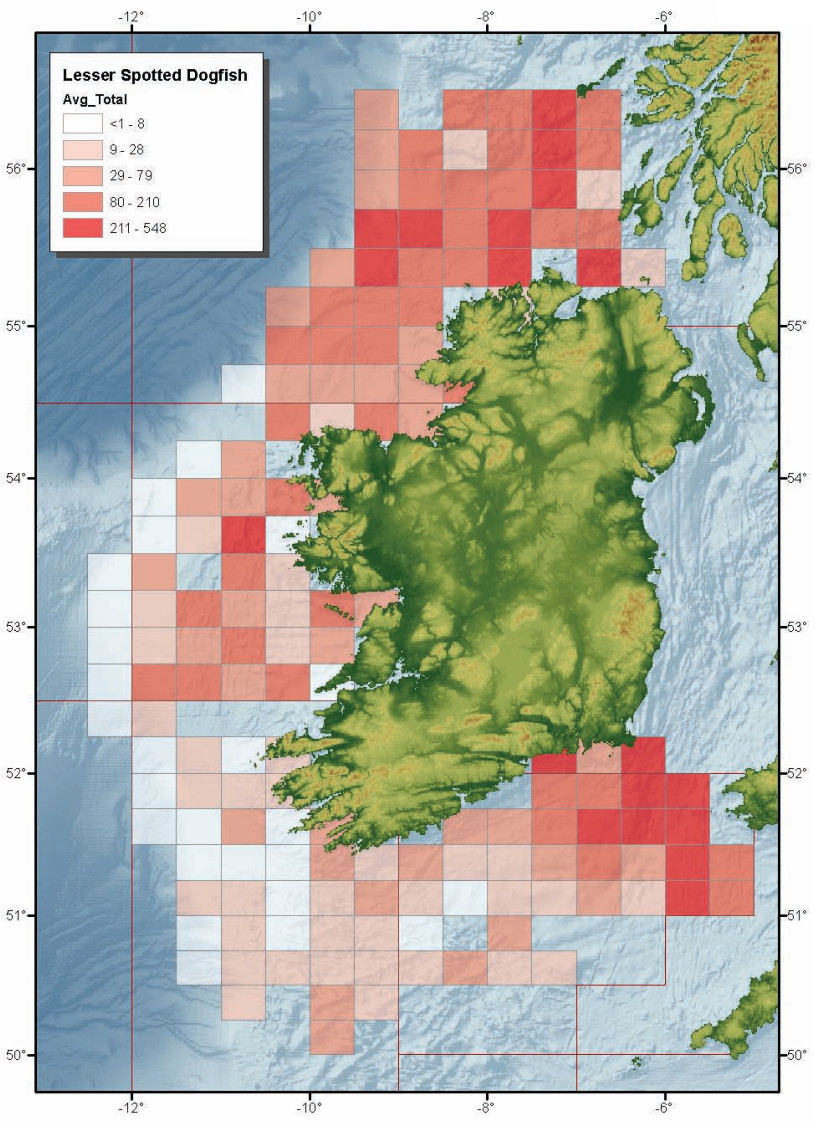
Catches – spurdog are generally taken in mixed demersal and gillnet fisheries. They were subjected to targeted fisheries but were also taken as bycatch in mixed trawl fisheries. The groundfish survey occasionally takes large hauls of spurdog. The frequency of such large hauls over time is a useful indicator of the overall abundance of the stock. Catch rates are dominated by large values in VIa at the beginning of the time series.



Lesser spotted dogfish - *Scyliorhinus canicula*

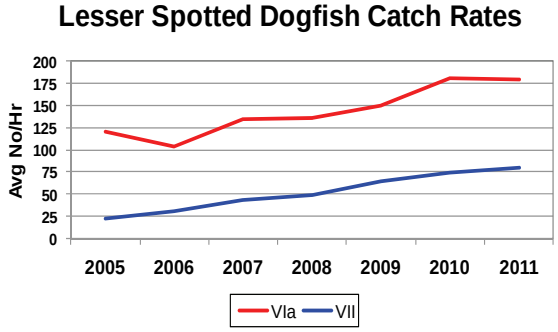
Biology – lesser spotted dogfish is the most common cat-shark in European coastal waters. The fish reach sexual maturity around 55cm and have a maximum size of around 100cm. The size range caught on the survey is from 9cm to 77cm with an average size of 45cm. Dogfish are egg laying species. Eggs can be laid all year but most are deposited from November to July. Feeding is largely on crustaceans, molluscs, and occasionally on fish.

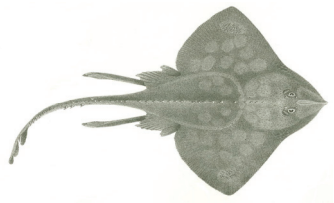




Distribution – lesser spotted dogfish are found in the northeast Atlantic from Norway, to Senegal, and also the Mediterranean Sea. On the IGFS, they are found from 10m to 700m depth and throughout the survey area, but in largest numbers off the northwest and south-east coasts.

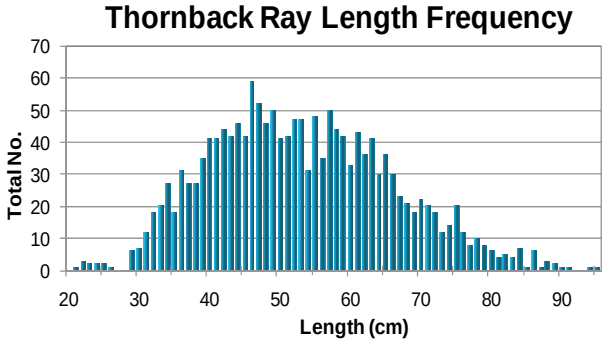
Catches – while lesser spotted dogfish catches on the survey have increased steadily in all areas since 2005, the catches have consistently been much larger in the north-west than to the west and south. This species is not landed for human consumption in Ireland, and is mainly discarded. However in some areas it is landed as bait in pot fisheries.

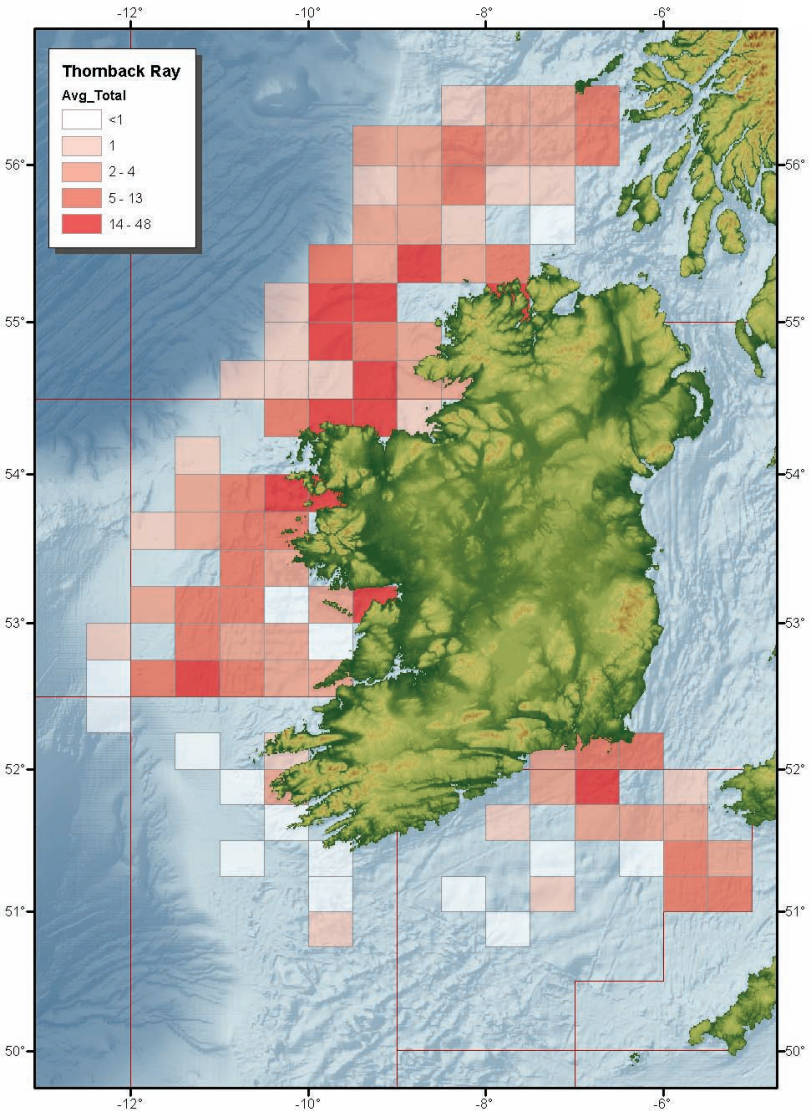




Thornback ray - *Raja clavata*

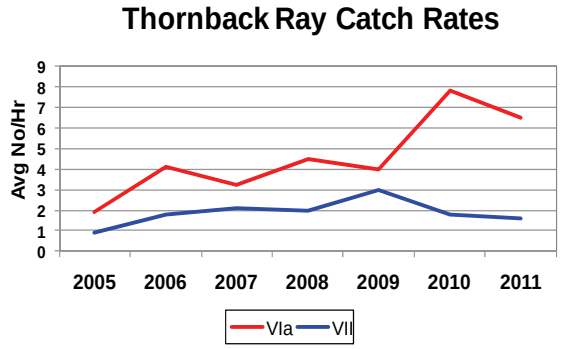
Biology – thornback ray caught on the survey range in size from 13cm to 95cm with an average length of 54cm. Male maturity is estimated to occur at seven years and female at nine years. They are oviparous and the female can lay between 62 - 74 eggs per year. They feed on all types of bottom animals, preferably crustaceans.

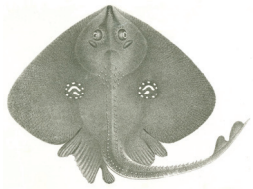




Distribution – thornback ray are found in the eastern Atlantic from Norway and Iceland to Morocco and Namibia, including the Baltic, Mediterranean and Black Seas. They are found on the continental shelf and upper slope down to 300m. On the survey they have been caught to the west and northwest and off the south-east at depths from 13m to 308m but at an average depth of 100m.

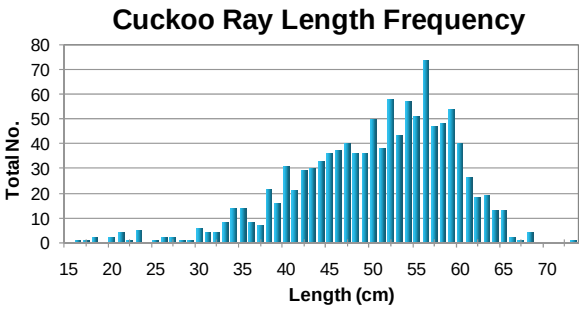
Catches – thornback ray are primarily caught by trawls. Annual catch rates in VIa have been about twice as high as in area VII until 2009 and show a steady increase over the time series with peak values in 2010.Survey catch rates in VII are stable at a low level.

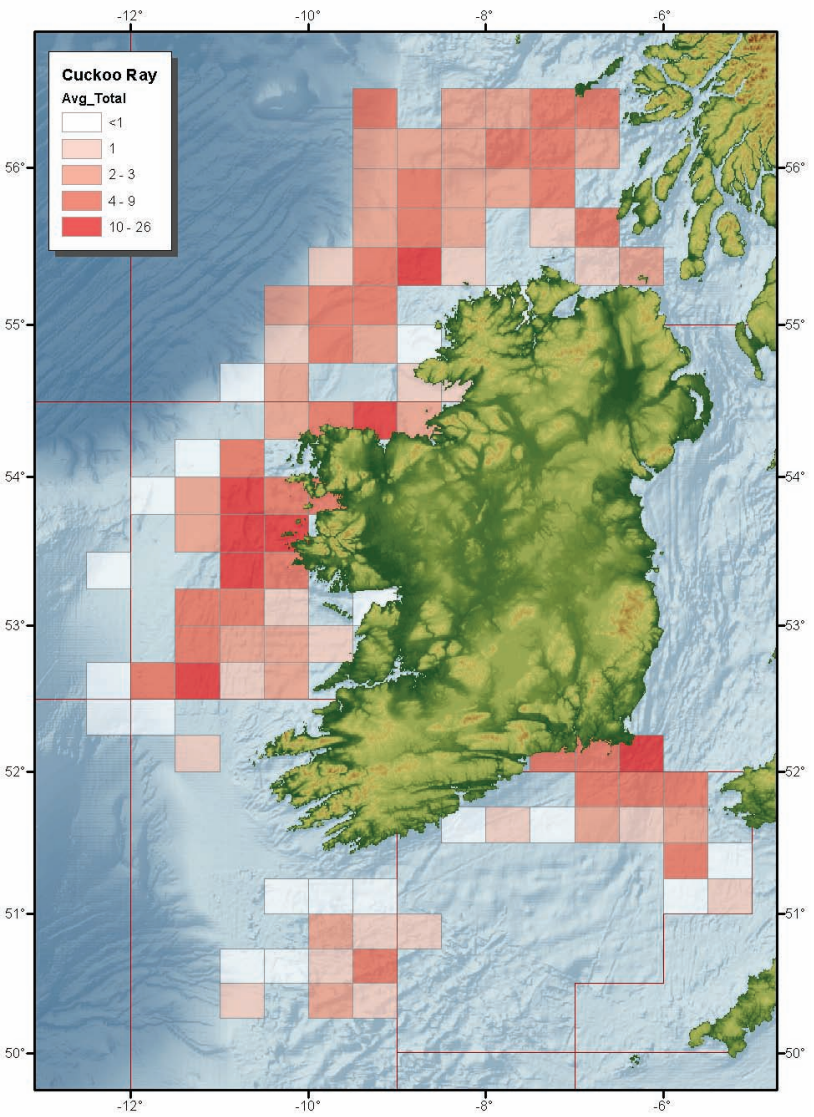




Cuckoo ray - *Leucoraja naevus*

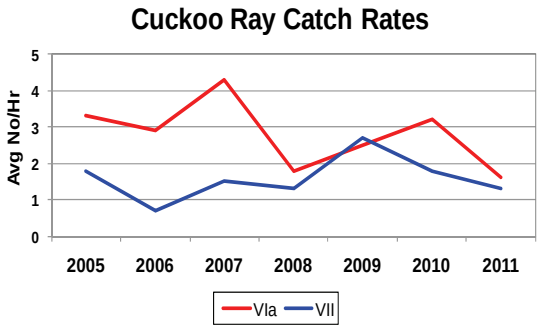
Biology – cuckoo ray can grow up to 75cm with females having a slightly larger maximum size. The size range caught on the survey is from 12cm to 73cm with an average of 47cm. They feed on a wide range of benthic organisms, particularly crustaceans. Females lay an average of 90 eggs per year. Ripe females have been observed during most months of the year, but mainly in spring.

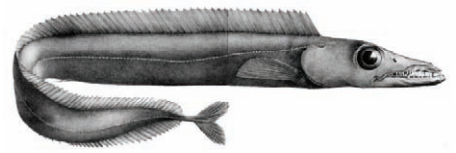




Distribution – cuckoo ray are found in the eastern Atlantic from the North Sea and west of Ireland to Senegal. They are also found in the Mediterranean Sea. On the survey cuckoo ray have been caught throughout the north-west and west and off the southeast coasts at depths between 26m and 372m with the average depth being 120m.

Catches – cuckoo ray are caught in trawls and on long lines. Cuckoo ray catch rates on the surveys appears to vary across years. No clear trends are obvious from these data, though the time series is short.

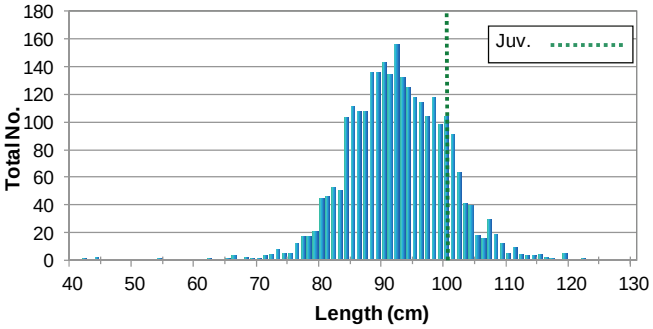


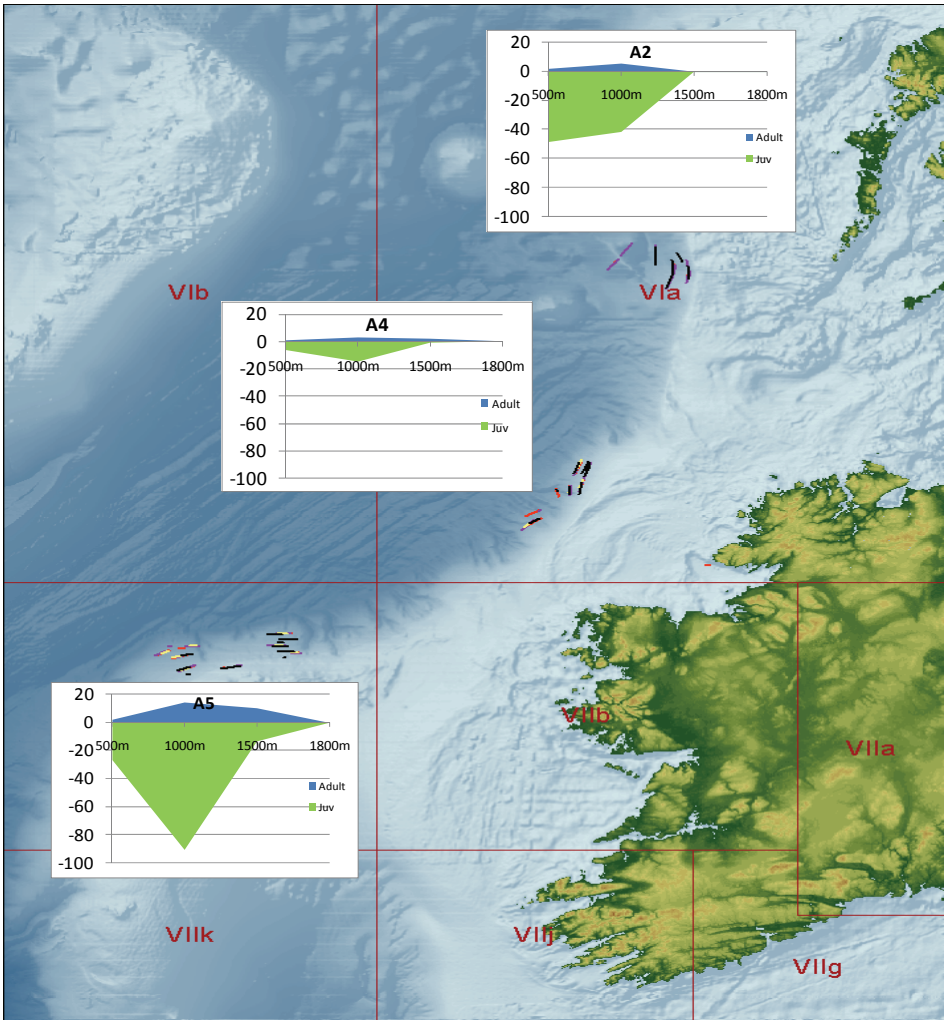


Black scabbard - *Aphanopus carbo*

Biology – black scabbard are relatively fast growing, attaining lengths of up to 150cm, and can reach 30 years of age. Fish caught on the Irish surveys ranged from 42cm to 122cm. Feeding is largely on fish and crustaceans.

Black Scabbard Length Frequency

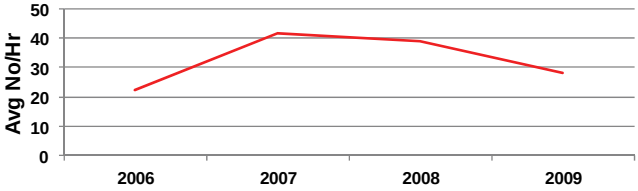


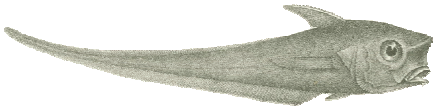


Distribution – black scabbard are distributed on both sides of the north Atlantic and on seamounts and ridges south to 30°N, at depths ranging from 500 to 1700m. They are found only sporadically north of the Scotland-Iceland-Greenland ridges. Juveniles are mesopelagic and adults are benthopelagic. It is thought that fish to the west of Ireland are pre-adults that migrate further south as they reach maturity. This is supported by deepwater survey data which show that juveniles are found between 500m and 1000m, primarily in areas 2 and 5.

Catches – black scabbard are caught by both longlines and bottom trawl in deepwater fisheries. Catch rates from the Irish deepwater survey increased between 2006 and 2007 but decreased again in 2008 and were reasonable similar in 2009. Black scabbard estimates could be improved by additional sampling at depths of 750m.

Black Scabbard Catch Rates

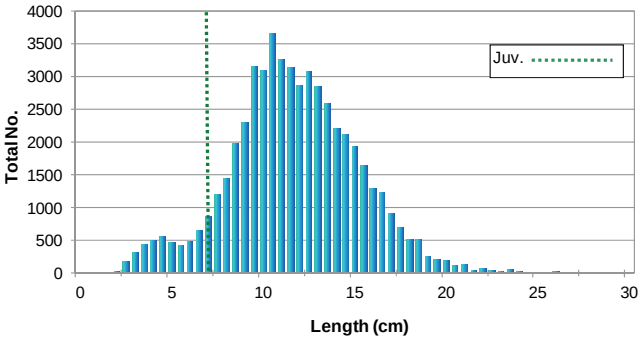


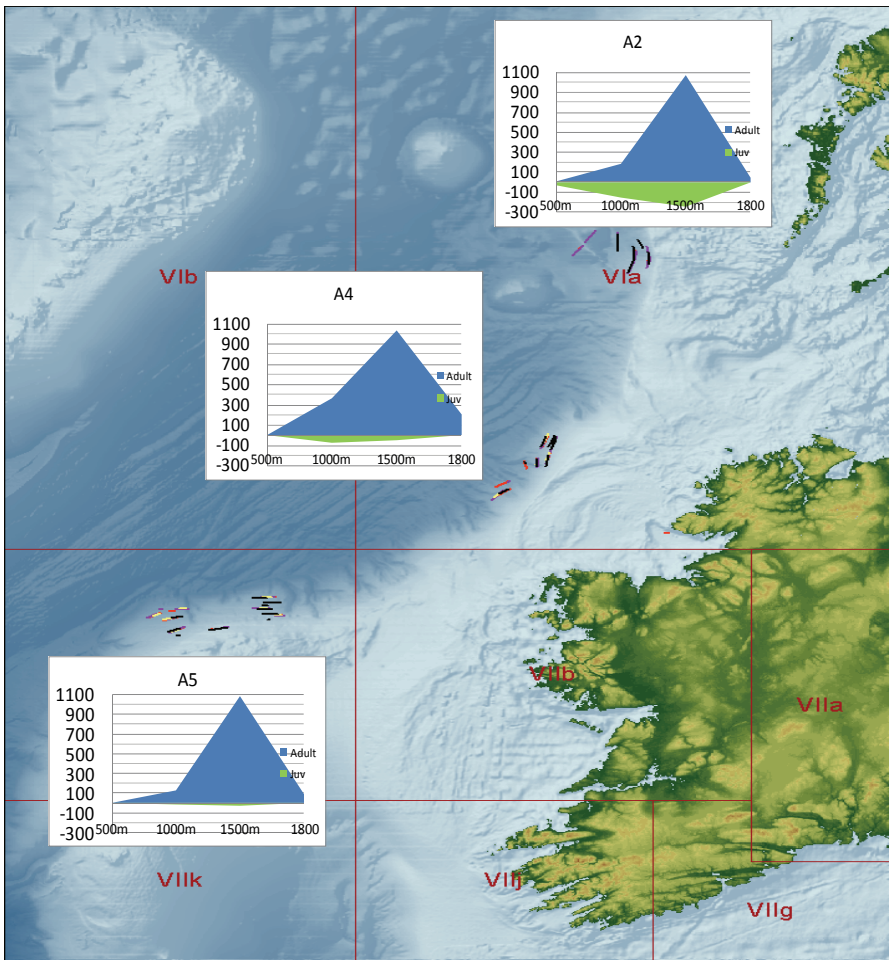


Roundnose grenadier - *Coryphaenoides rupestris*

Biology – roundnose grenadier is a long lived species, achieving ages of up to 60 to 70 years. Females are thought to reach maturity between 9 and 14 years old at lengths between 11 and 12.5 cm. Spawning appears to extend from May to November. Feeding is largely on fish and crustaceans with molluscs and worms also being consumed.

Roundnose Grenadier Length Frequency

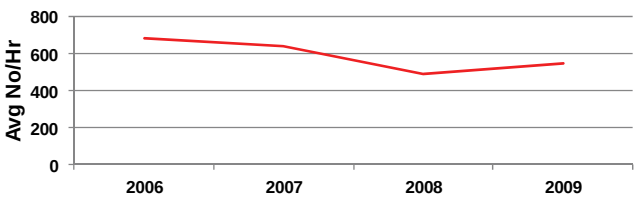


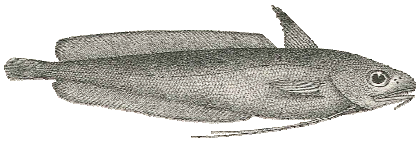


Distribution – roundnose grenadier is widely distributed in the north Atlantic. It can be found along the continental shelf of North Africa, Europe, Iceland, Greenland, Canada and the US, at depths ranging from 180 to 2200m. Roundnose grenadiers are slow moving fish and there is no direct evidence of long distance migrations being made by adult fish. Survey catches on the Irish deepwater survey were highest at 1500m, but the species was caught in most tows between 1000m and 1800m. Juveniles were mainly caught in area 2 at depths of 1000m and 1500m.

Catches – commercially, roundnose grenadier are landed by bottom trawls, mainly from mixed deepwater trawl fisheries. Survey catch rates have been high and relatively stable through the series, though the time series is short in relation to the history of exploitation of this species.

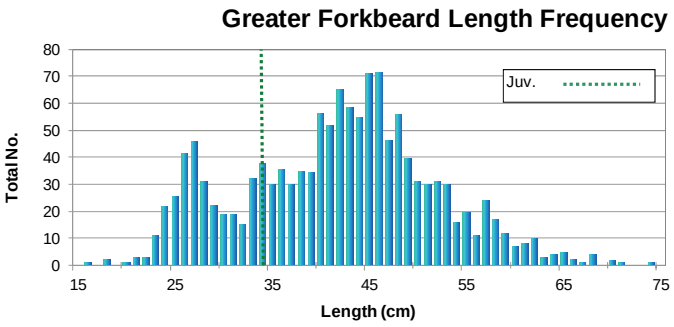
Roundnose Grenadier Catch Rates

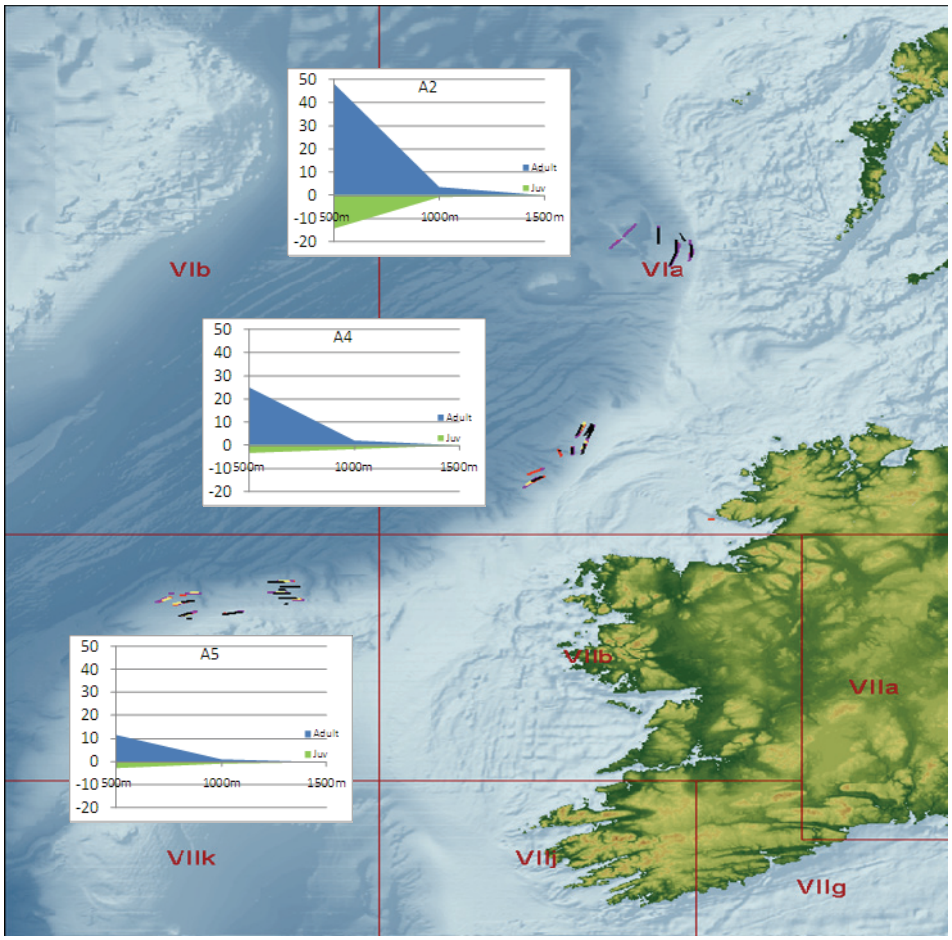




Greater forkbeard - *Phycis blennoides*

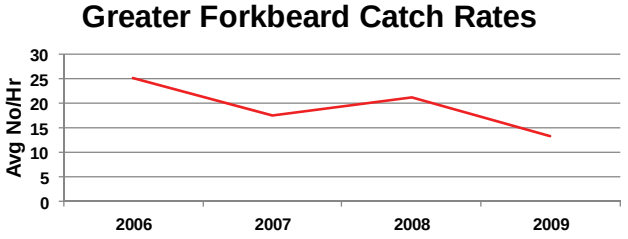
Biology – greater forkbeard are fast growing and most fish are sexually mature by 3-4 years of age. Maximum recorded age is about 9 and maximum length is about 85 cm. They feed mainly on crustaceans and fish.

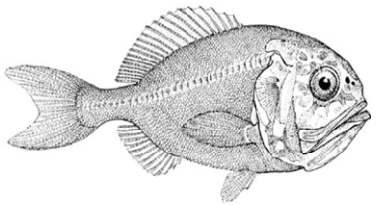




Distribution – greater forkbeard is a gadoid fish that is widely distributed in the north Atlantic. It can be found along the continental shelf and slopes at depths ranging from 60 to 800m, although recent work suggests it may be found at depths in excess of 1000m. On the deepwater surveys the fish were primarily caught at 500m, and there was a gradual decrease in numbers from north to south. Juveniles were mainly encountered in area 2.

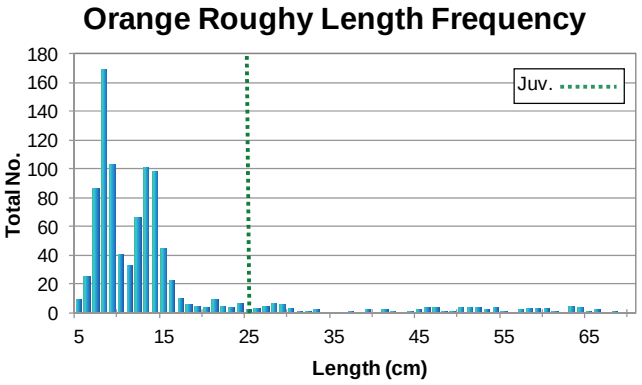
Catches – greater forkbeard are generally caught as bycatch in bottom trawl and longline fisheries in shelf and deepwater fisheries. Catch rates from the Irish deepwater survey decreased during the four years of the time series.

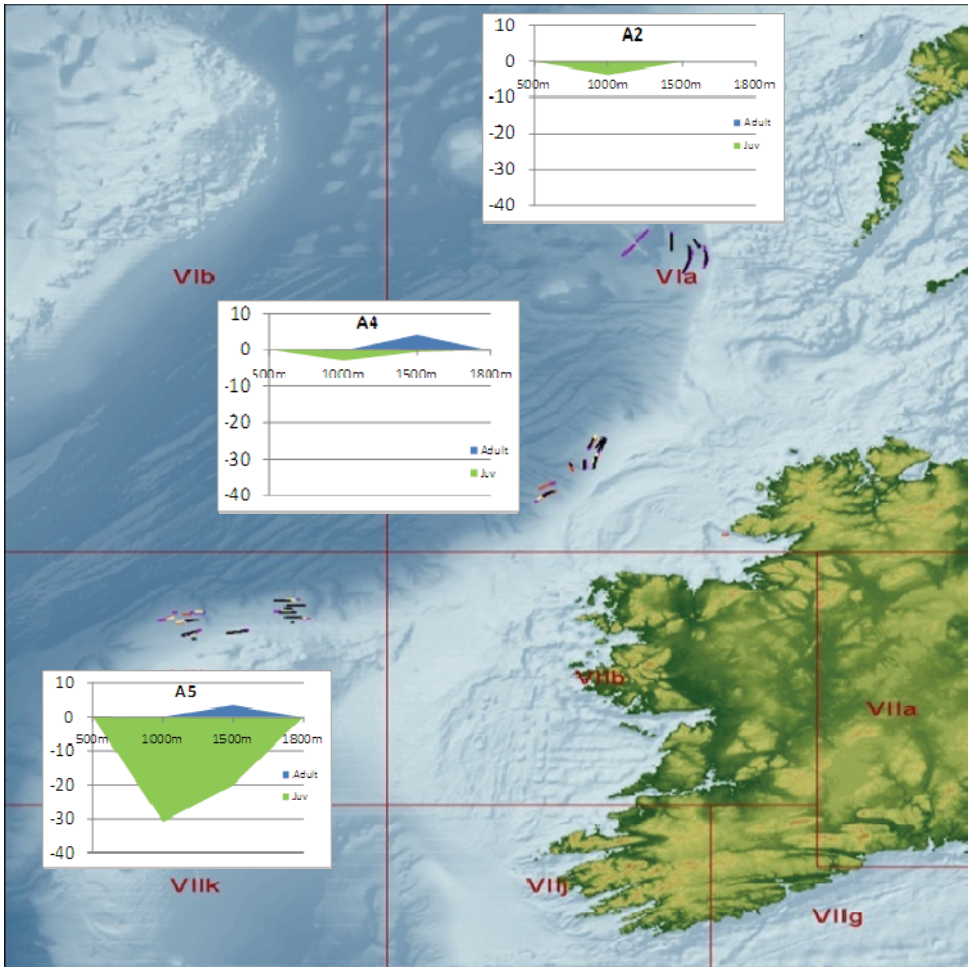




Orange roughy - *Hoplostethus atlanticus*

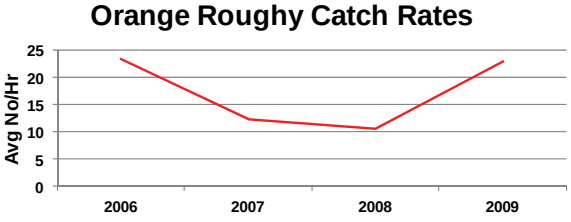
Biology – orange roughy are very slow growing reaching ages in excess of 130 years. They form discrete spawning aggregations around bathymetric features such as seamounts, and reach maturity at around 30 years of age. Females produce roughly 150 000 eggs. Feeding is largely on fish and crustaceans with molluscs and worms also being consumed.

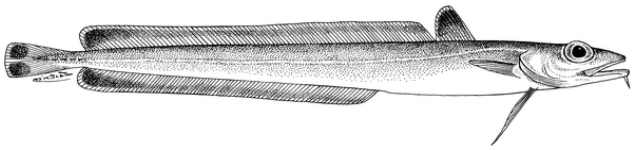




Distribution – orange roughy is widely distributed in the world's oceans. It inhabits deep waters over the continental slopes, seamounts and ocean ridges between 500m and 1500m. Adult fish are known to congregate above seamounts, and the Irish deepwater survey does not catch many adult fish. Juveniles inhabit the continental slope and the deepwater survey catches juveniles. These juveniles are caught in large numbers in area 5.

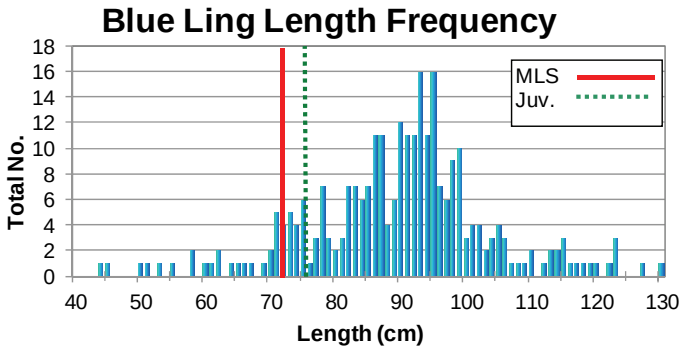
Catches – orange roughy are normally caught by bottom trawls but there are currently no directed fisheries targeting orange roughy in ICES subareas VI and VII. While demersal trawling is therefore a suitable sampling technique for this species, low catches overall mean data for any one year are inherently variable. High survey CPUE data indicate catches of large numbers of juvenile fish.

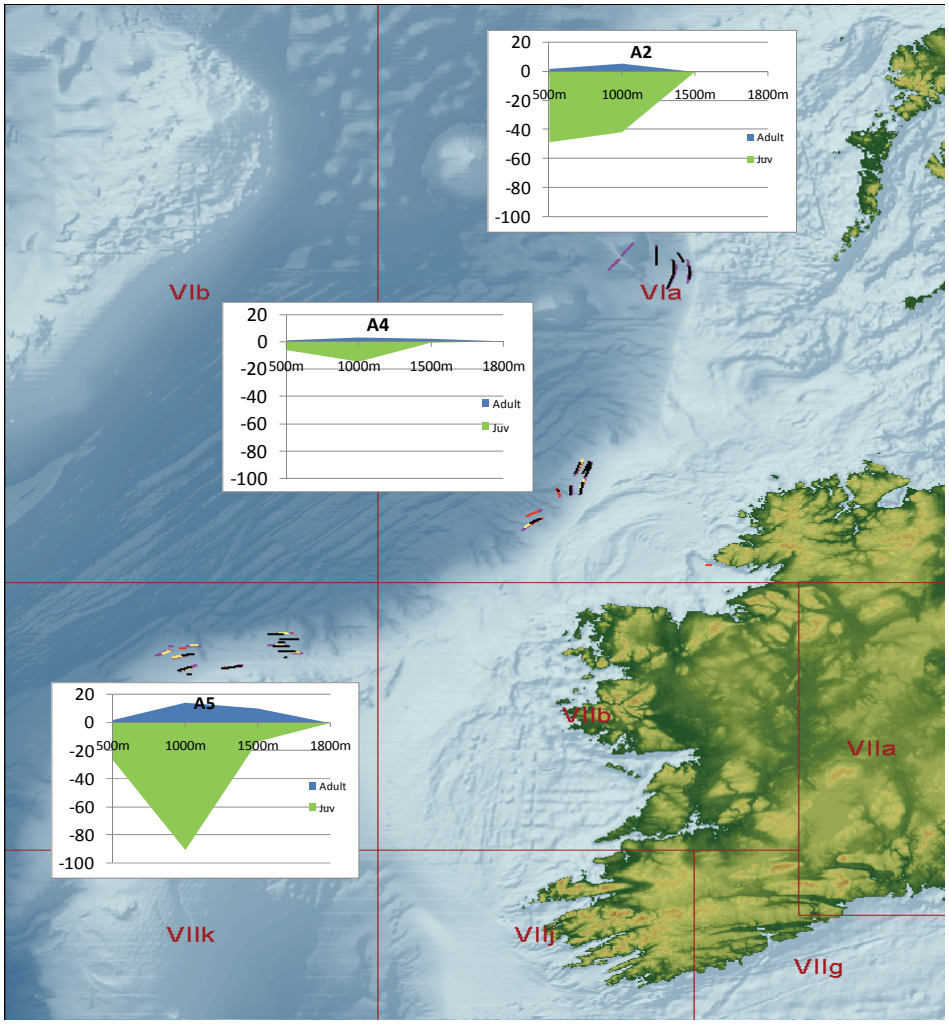




Blue Ling - *Molva dypterygia*

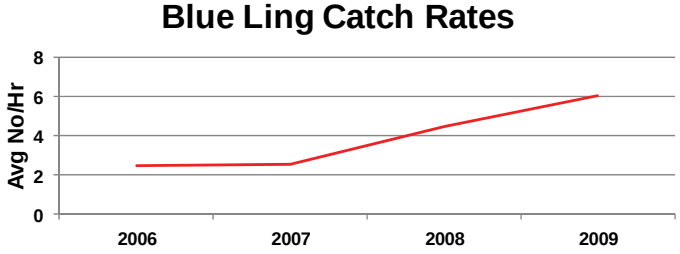
Biology – blue ling reach a size of 80 cm by age 6 to 7 and reach maturity at about this age. They can reach a maximum size of 145 cm and an age of 30 years. They feed largely on fish and crustaceans.





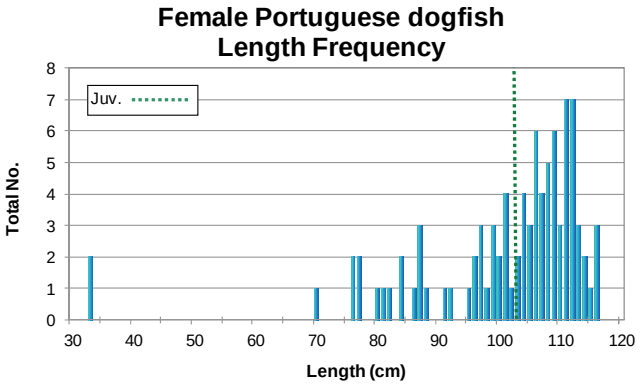
Distribution – blue ling is widely distributed in the northeast Atlantic. Its main depth range is from 400 to 1200m with peak abundance around 800m. Blue ling display seasonal spawning aggregations, especially around offshore banks, between March and May, and are more scattered during the rest of the year. On the Irish surveys peak abundances were found at 1000m in areas 4 and 5, and 500m in area 2, however numbers were low. Analysis of commercial data would indicate peak numbers at depths ranging 600 to 700m, which the Irish deepwater survey doesn't target.

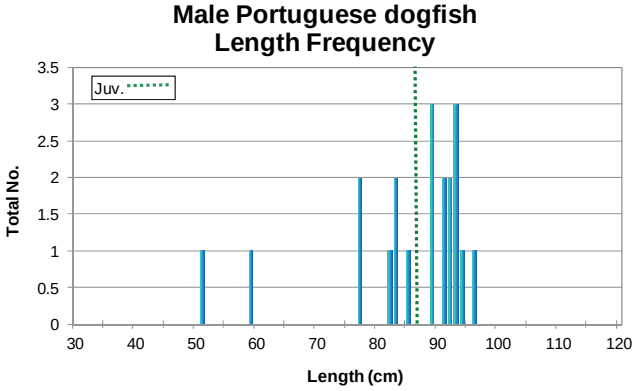
Catches – blue ling are generally caught with bottom trawls and longlines in deepwater fisheries. Survey catch rates have shown a gradual increase since 2007. Due to the aggregating behavior of blue ling, catch rates can be variable and need to be interpreted with caution.

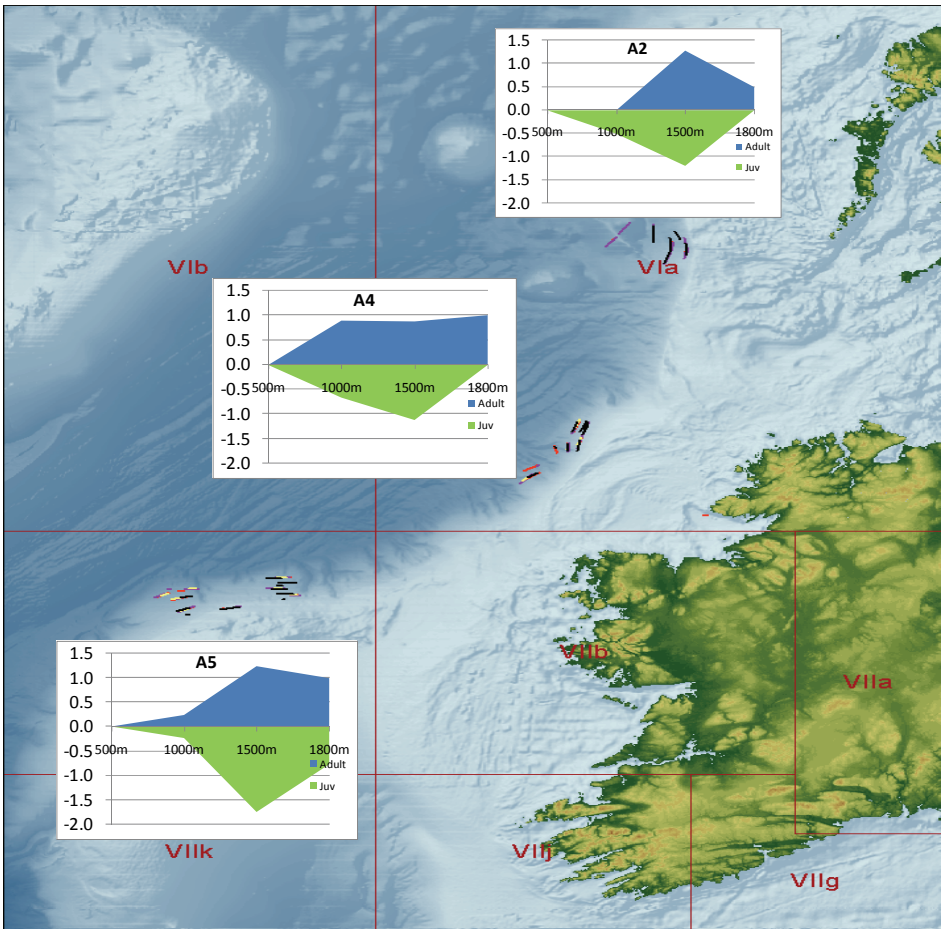


Portuguese dogfish - *Centroscymnus coelolepis*

Biology – Portuguese dogfish are slow growing and reach lengths of 120cm, with females tending to be larger than males. Specimens smaller than 70cm are rarely found in the northeast Atlantic. Females are mature around 100cm and males around 85cm. They are ovoviviparous and on average produce 13 embryos. This species is vulnerable to overfishing. Feeding is mainly on fish and crustaceans.

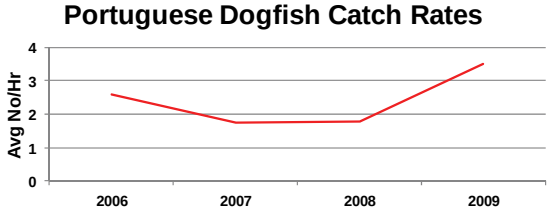






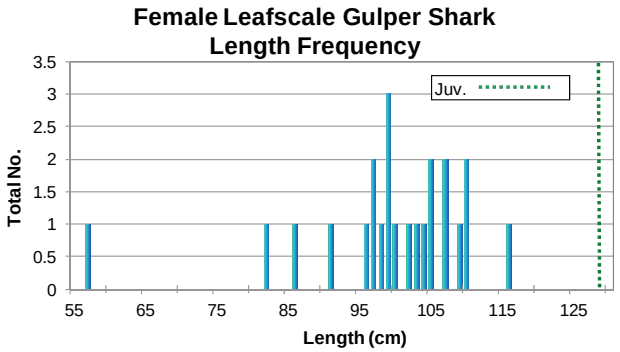
Distribution – Portuguese dogfish are widely distributed in the north Atlantic, as well as the Indian and Pacific oceans. They have a large depth range but are most commonly found between 400 and 2000m.

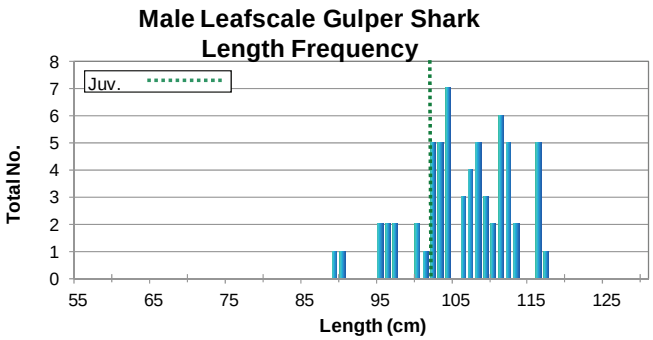
Catches – there is currently no directed fishery for this species, though bycatches in mixed fisheries are discarded. Historically Portuguese dogfish were caught in mixed bottom trawl fisheries, and in mixed or directed longline fisheries. Survey catch rate trends are not informative as the time series is short in relation to the history of its exploitation and its life history characteristics.

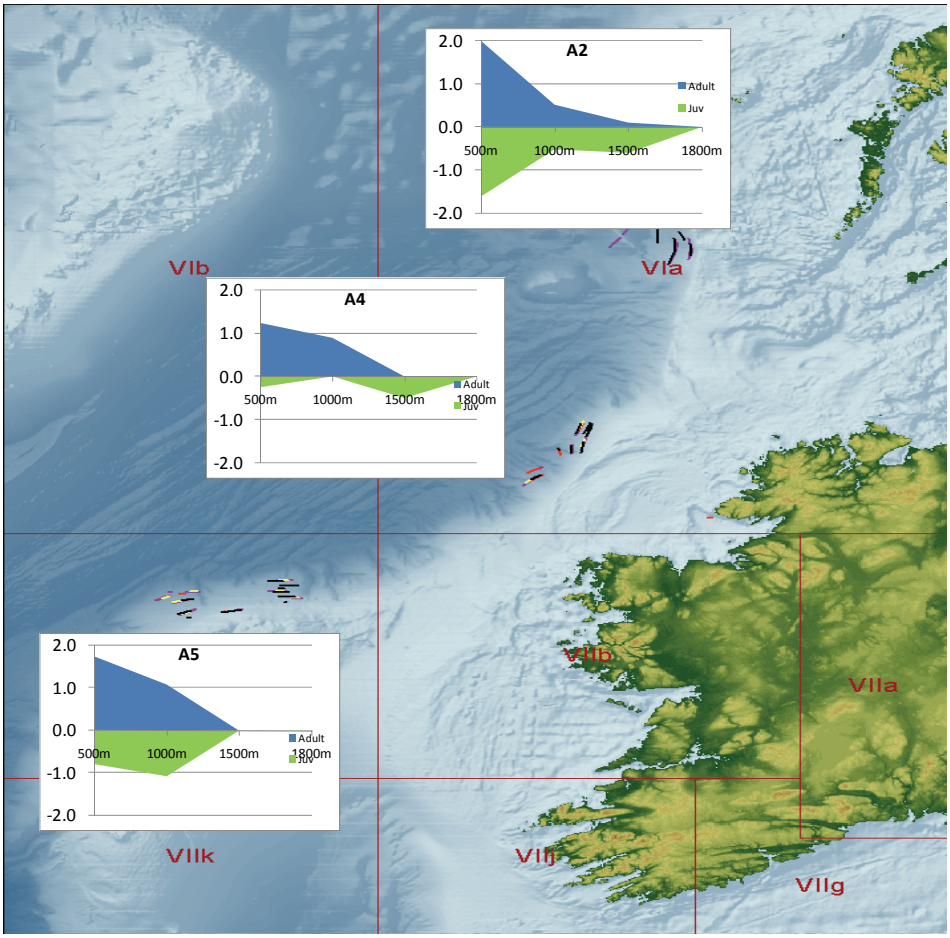


Leafscale gulper shark - *Centrophorus squamosus*

Biology – Leafscale gulper sharks are slow growing, reaching lengths of about 160cm, and ages of up to 70 years. Females are larger than males and reach maturity at about 128cm. Males reach maturity at about 102cm. Females produce up to 5 young at a time. Due to its longevity and low fecundity this species is very vulnerable to overfishing. Feeding is largely on fish and cephalopods.

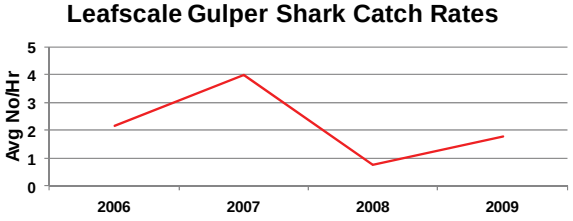






Distribution – Leafscale Gulper shark is widely distributed in the northeast Atlantic, the western Indian Ocean and the western Pacific Ocean. It can live as a demersal shark on the continental slopes down to 2400m, or as a pelagic shark, occurring in the upper 1250m in areas with depths around 4000m. The species is thought to be highly migratory. On the Irish deepwater survey this species was found primarily between 500m and 1000m.

Catches – there is currently no directed fishery for this species, though bycatches in mixed fisheries are discarded. Historically Leafscale gulper sharks were caught in bottom trawls, line gear and fixed bottom nets. Survey catch rate trends are not informative as the time series is short in relation to the history of its exploitation and its life history characteristics.



Case study 1: Fish stock assessment for Celtic Sea haddock

Using commercial vessel catch and effort data to assess fish resources has two major drawbacks. 1: fishermen go to where the marketable fish are and 2: they are of necessity changing their fishing behaviour and improving their catching efficiency. This has the potential to bias commercial data when it is used as an indicator of stock abundance. There are many examples of cases where commercial Landings Per Unit Effort (LPUE) remained stable or increased as the underlying stock declined (or indeed the opposite where a fleet stopped targeting a species and LPUE declined but the stock did not). Consequently scientists develop time series of data using scientific surveys. These are called "fishery independent surveys".

Surveys are carried out to provide precise and accurate abundance indices that are proportional to the stock size and hence will reflect stock trends and any changes to management regimes. Surveys such as the International Bottom Trawl Surveys (IBTS) attempt to provide useful indices and biological data for many groundfish species simultaneously. The relative abundance indices are used to calibrate or "tune" the stock assessment population models. In many cases the reliability of stock assessment is greatly influenced by the precision of the survey estimates.

Survey indices are typically age or length structured and often target juvenile fish more so than adults. If surveys can provide a reasonably accurate indication of year class strength before they enter the commercial fishery this information can be used to forecast stock development and short term changes in expected catch. Such observations are especially important for stocks where recruitment variability is high and/or a high proportion of the landings are made up of incoming year classes.

Celtic Sea Haddock

Haddock stocks are characterised by periods of very strong recruitment. Haddock in the Celtic Sea have been increasing in abundance over the last 15 years. The stock has produced several strong year classes and a few exceptional ones over that time period (Figure 5.1). A large proportion of the catch in number and weight are discarded, but sampling of the discards has been very sparse and incomplete for the full time series. Part of the discard problem is that management has not reacted quickly enough to increase or decrease the total allowable catch (TAC) in response to year class strength. But full stock assessments have not been feasible to inform management properly up to now. This was mainly because of the high uncertainties in the level of catch (primarily discards) and a relatively short time and somewhat conflicting series of survey data. ICES has recently agreed an assessment methodology for this stock.

Two IBTS surveys cover the distribution of the Celtic Sea haddock stock (ICES divisions VIIb-k). The French survey commenced in 1997 and covers the southern part of the stock distribution, while the Irish survey commenced in 2003 and covers the northern and western parts (Figure 5.2). A combined French and Irish index proved to be better at tracking the strength of year classes and provided more consistent estimates of mortality. Ultimately the combined index from ages 0-5 was used to calibrate the stock assessment model. Having survey information was particularly important in this example since it can provide relatively consistent information for the younger ages which were highly uncertain due to discarding. The surveys also provide an important input to the forecast of short term catch. This is especially important for haddock where large year classes can lead to large changes in fish abundance on the fishing grounds.

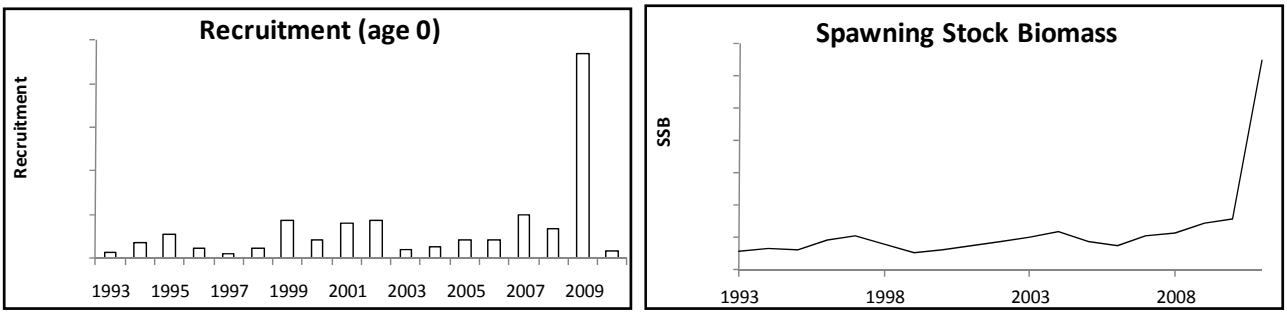
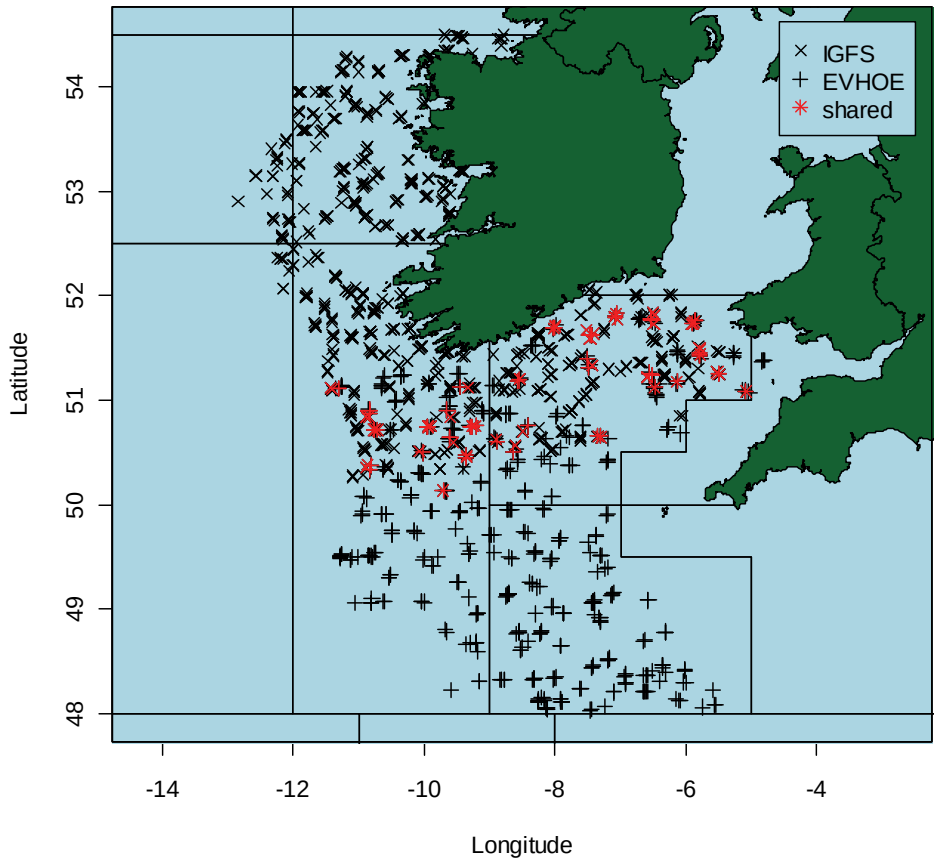


Figure 5.1 **Celtic Sea Haddock: Trends in recruitment and spawning stock biomass as calculated in the stock assessment model. Note the very high biomass in the final year, as a result of the exceptional 2009 recruitment.**



Haddock stocks are characterised by periods of very good recruitment which greatly increase the abundance of the stock.

Figure 5.2 **Survey coverage (all stations, full time-series) of the Irish (IGFS) and French (EVHOE) surveys in VIIb-k. Stations that were sampled in the same year by both surveys are highlighted in red (65 stations in total).**

Case study 2: The application of survey data to new ecosystem advice

In recent years, society has recognised that the management of human activities in the ocean, including fishing, needs to incorporate ecosystem considerations. This is manifested in several international conventions to which Ireland and the EU are signatories, e.g. the Convention on Biological Diversity (CBD) and the United Nations Convention on the Law of the Sea (UNCLOS). Overarching commitments of these conventions are the protection and the preservation of the marine resources and biodiversity. Furthermore there is a requirement to incorporate these into the development and management of the policies that affect the marine environment. The incorporation of ecosystem considerations into marine management is termed the **Ecosystem Approach to Marine Management** (**EAMM).** This approach requires a new form of ecosystem advice.

In recent years, the EU has been developing an ocean policy for all users of marine space. This is the EU maritime policy. The environmental pillar of the EU maritime policy is the **Marine Strategy Framework Directive** (MSFD), which is a mechanism for Europe to implement its commitments under international conventions such as CBD and UNCLOS into European law as part of the ecosystem approach. The MSFD requires member states to develop a marine strategy to protect and preserve the marine environment and manage human activities in a sustainable way. For this purpose, Good Environmental Status (GES) needs to be achieved by 2020 which is defined by 11 qualitative descriptors. Descriptor 1 relates to marine biodiversity and preventing the decline of biodiversity is a key objective of the Marine Directive.

Biodiversity is the variety of plant and animal life in the world or in a particular habitat- a high level of which is usually considered to be important and desirable.

(Oxford Dictionary)

In relation to biodiversity, GES is defined as the following: *"Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climate conditions. "*

European member states have to develop a suite of targets and indicators that measure their progress towards GES. Fish surveys such as the two Irish groundfish trawl surveys described in this atlas will be crucial in providing time series as well as spatial data on the fish biodiversity indicators which underpin descriptor 1 of the MSFD. The following case study describes how the data from the two groundfish trawl surveys can be used to describe the biodiversity of the demersal fish community and how the impact of fishing on the wider fish community can be measured.

Good **E**nvironmental **S**tatus under the MSFD:
The 11 descriptors to ensure a healthy and productive marine ecosystem by 2020

D1	Biodiversity is maintained
D2	Non-indigenous species do not adversely alter the ecosystem
D3	The populations of commercial fish species are healthy
D4	Elements of food webs ensure longterm abundance and reproduction
D5	Eutrophication is minimised
D6	Sea floor integrity ensures the functioning of the ecosystem
D7	Permanent alteration of hydrographical conditions does not adversely affect the ecosystem
D8	Concentrations of contaminants have no effects
D9	Contaminants in seafood are within safe levels
D10	Marine litter does not cause harm
D11	Introduction of energy (including underwater noise) does not adversely affect the ecosystem

Patterns of species richness and biodiversity in the ground fish and deepwater fish communities

To describe the marine fish community, several different indicators can be used. Classical biodiversity indicators measure the species richness and diversity of a community. These indicators, calculated for the fish communities of the IGFS and the IDS, show the following patterns: Data from the ground fish survey shows that the number of species caught in a single haul varies spatially. The coastal hauls in the north of the survey area have a relatively low number of species, as do the deeper strata along the shelf edge (Figure 5.3). The shelf area in the Celtic Sea and west of Ireland, on the other hand, is species rich with a mean value of over 25 species per haul in most rectangles (Figure 5.4). Species diversity follows a similar spatial pattern to species richness with highest diversity on the shelf and in some inshore strata and lowest diversity in the slope strata.

Species richness (R) *is the number of species in a given survey haul or an entire survey.*
Species diversity (H') *also called the Shannon Wiener index incorporates the total number of species and their individual proportions to total numbers. It therefore takes into account whether species in a community are evenly distributed or dominated by a few.*

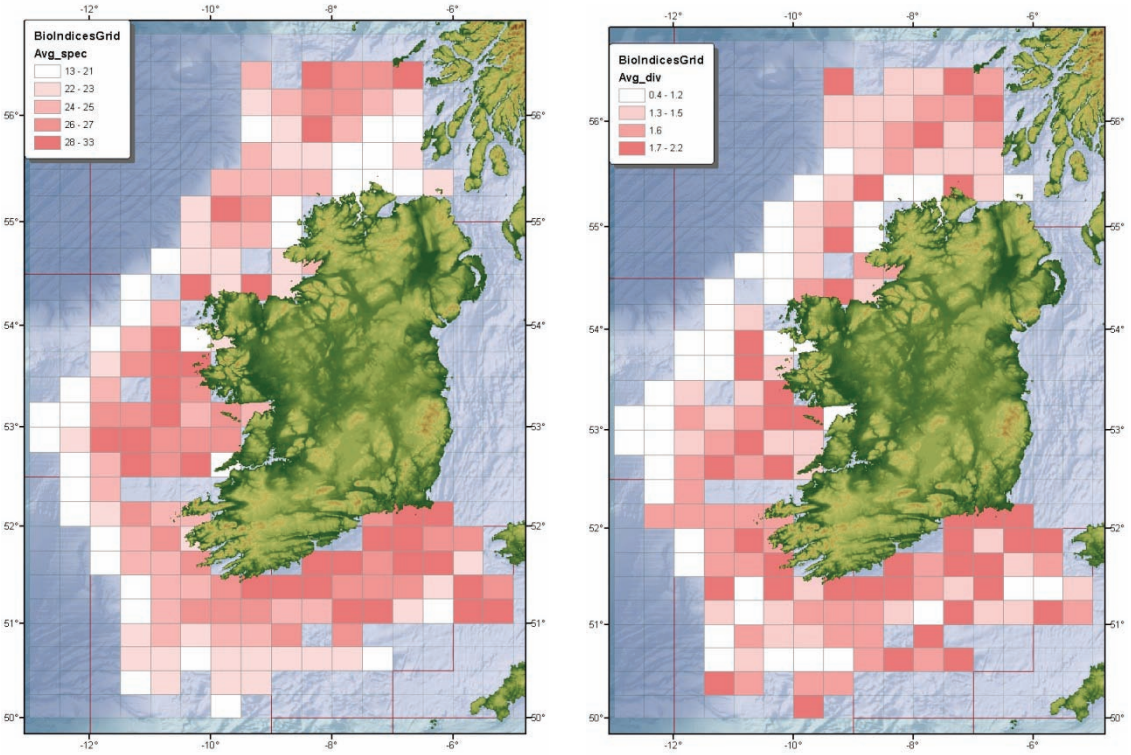


Figure 5.3 **Species richness (right) and species diversity (left) in the fish community of the IGFS.**

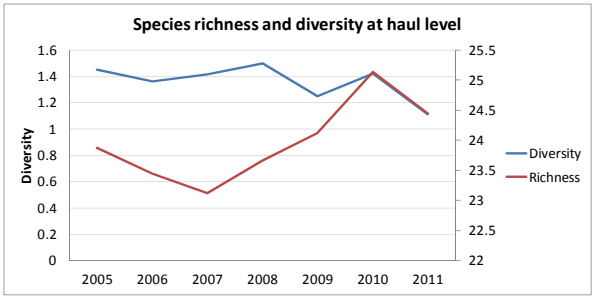


Figure 5.4 **Species richness and diversity at a haul level of the IGFS fish community over time.**

Overall, on the groundfish survey ca. 100 to 120 fish species are identified and sampled every year. While diversity at a haul level seems to have decreased slightly in recent years, there has been an increase in richness from an average of ca. 23 species per haul to around 25 species in 2010.

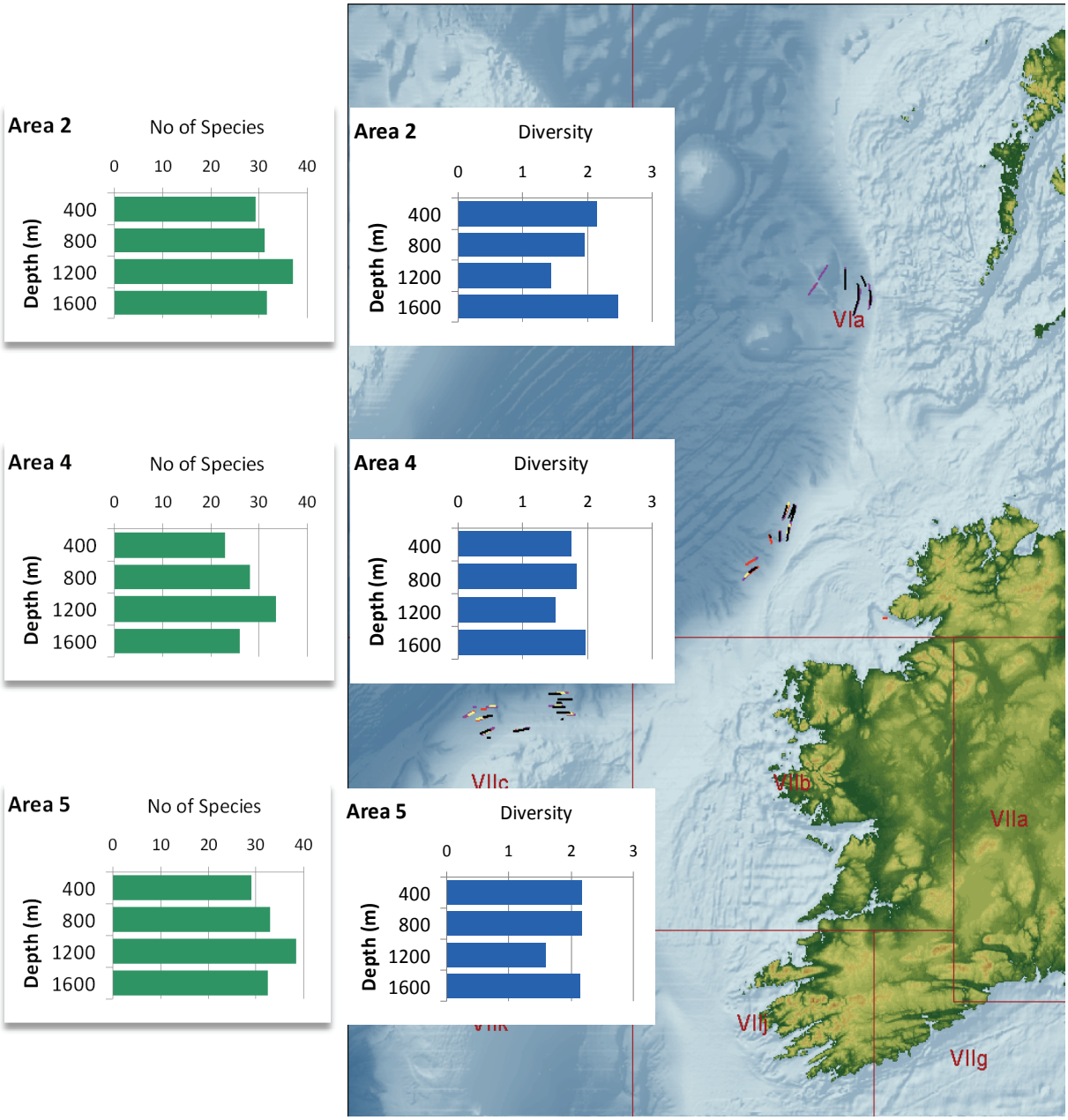


Figure 5.5 **Species richness (left) and species diversity (right) in the deepwater fish community as sampled by the IDS.**

More than 170 fish species have been caught on the deepwater survey programme. The average number of species is similar in the three areas with Area 4 having on average slightly fewer species (Figure 5.5). Species numbers in all three areas increase with depth up to the 1200- 1600m depth strata and decrease below a depth of 1600m. The diversity index behaves the opposite way with lowest diversity in the 1200-1600m in all areas. This is due to the strong dominance of a few species such as roundnose grenadier within this stratum.

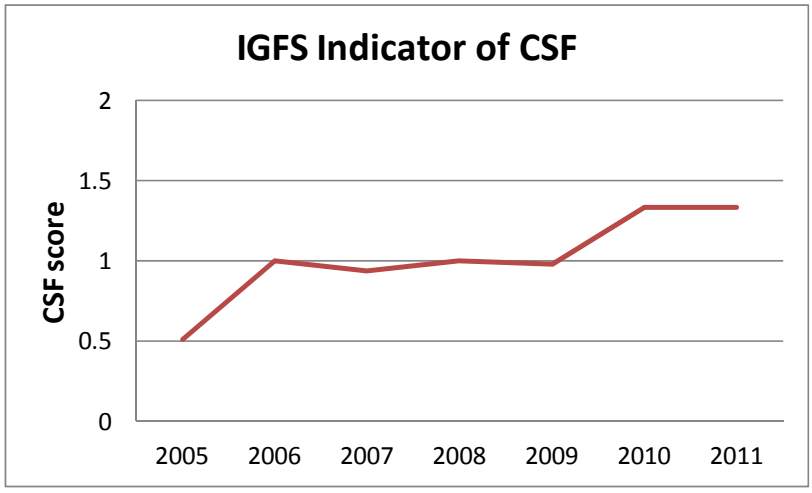
Evaluating the effects of fishing on the wider fish community

In order to evaluate the effect of fishing on the wider ecosystem, **indicators** need to be selected which are sensitive and responsive to the activity, tightly linked in time and space and easily measured. The response of **biodiversity indicators** to the effects of fishing on the community is not always clear. In areas of high species dominance, fishing might extract the dominant commercial species and thereby increase evenness and diversity. In areas, where there is a high evenness already, fishing can decrease diversity by depleting several of the less abundant species resulting in a decrease in species richness.

Size based indicators are considered more suitable to measure the effects of fishing on the fish community as there is a clear response to fishing impacts. The effects can be direct as fishing selectively extracts larger individuals in a population and larger species in a community. The effect on size can also be indirect as small prey fish increase in their abundance due to the absence or reduction of their larger predators.

The application of Irish groundfish survey data to two size based indicators are presented here. These are the **Conservation Status of Fish indicator (CSF)** and the **Large Fish Indicator (LFI).** Both indicators are used by European countries to evaluate the effects of fishing on the ecosystem as part of their requirements to collect fisheries data under the data collection framework. They are also proposed indicators to feed into the biodiversity (D1) and the foodweb descriptors (D4) of the MSFD.

The Conservation of Fish Indicator: The CSF is based on the relative population abundance of selected vulnerable fish species to provide a measure of their conservation status. It aims to assess the threat and the decline of a list of vulnerable fish species in a composite indicator. The indicator uses the maximum size of a species as a proxy for its overall vulnerability. The species included in the indicator are the 20 largest species that are caught in the time series of the survey. The list of species that are captured by the CSF, i.e. the 20 species with the largest L_{max} (maximum sizes) on the Irish groundfish survey include most of the important elasmobranch species, which have a high level of vulnerability, and some of the large teleost species such as conger eel, hake, ling, cod and anglerfish.



Irish groundfish survey data suggests that there is an improvement in the conservation status of vulnerable fish species in waters around Ireland.

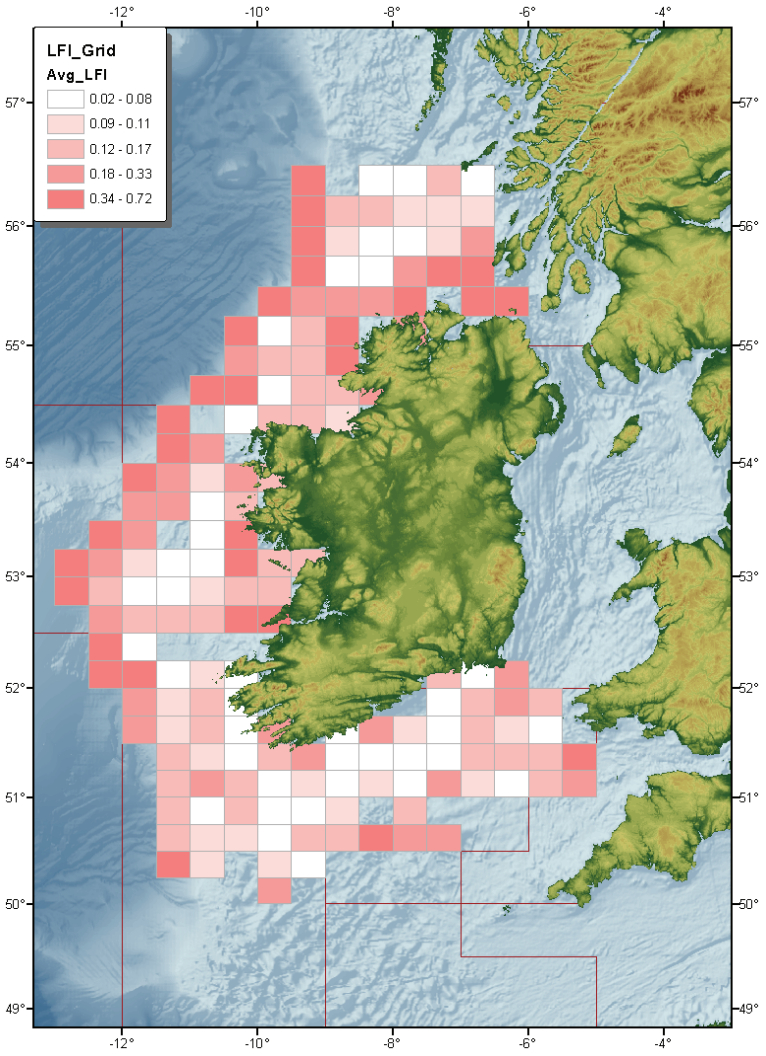
Figure 5.6 Time series of the CSF for the IGFS.

The time series of the CSF is short but values are increasing in the last years (Figure 5.6). This is due to the majority of the listed species showing upward trends in the abundance of their larger individuals. The result of this indicator suggests some recent improvements in the conservation status of these species in the demersal fish community around Ireland.

The Large Fish Indicator: The LFI is a size based indicator which measures the proportion of large fish by weight in the fish community. It reflects the size structure of populations and the life history composition of the fish community. The indicator was originally developed for the North Sea fish community and measured the proportion by weight of fish above 40cm. It aims to monitor the recovery of the overexploited fish community towards larger sizes in the populations and an increase in the proportion of larger fish species.

The "large" fish threshold is set at a level that reduces the impact of variation in recruitment events, while still maintaining the indicators' sensitivity. The optimal cut off point for the Irish ground fish survey is currently being evaluated and analysis for other surveys in the Celtic Sea suggests that a 50cm threshold might be optimal.

Data on the large fish indicator from the Irish ground fish survey indicate that there is large spatial variability, i.e. the indicator varies more across the survey area than over the years (Figure 5.7). In the deeper slope strata the LFI (based on a 50cm threshold) can be up to 0.7. Along the shelf strata the LFI is only around 0.1 to 0.2. The difference is due to different species communities along the slope and the shelf. In deeper waters there are many large species such as hake and monkfish while most of the smaller demersal prey species are found in the shallow shelf stations. The single species section of this atlas demonstrates the strong spatial patterns of the most important species sampled by the IGFS and can give clues why the size structure of the fish community is so variable in space. Some inshore areas, especially in the Northwest, are also characterised by very high LFIs, i.e. fish communities where large sized fish dominate.



Groundfish survey data suggests that there is high variability in the proportion of large fish across the survey area, reflecting the spatial patterns of different species compositions.

Figure 5.7 **Spatial pattern of the large fish indicator based on IGFS data.**

Over time, the large fish indicator has been fluctuating between around 0.1 and 0.2 for the shelf strata (Figure 5.8). In 2006, the proportion of large fish was almost 0.2, but in any other year, it is closer to 0.1. For the deeper strata, the recent years indicated quite a strong increase to almost 0.5.

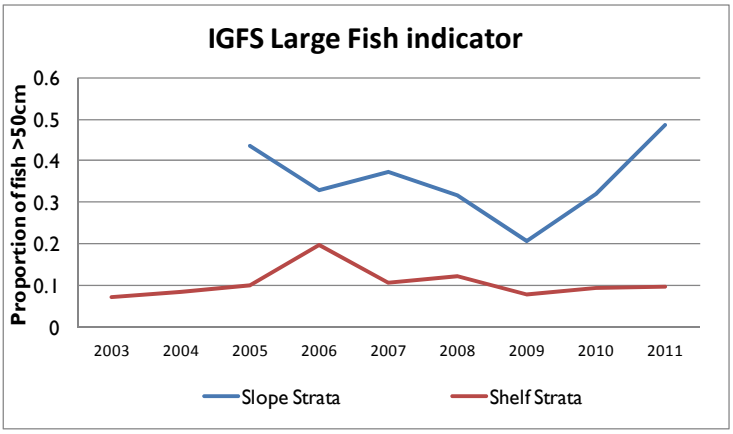


Figure 5.8 **Time series of the large fish indicator based on IGFS data.**

The large fish indicator is intended to measure the effect of fishing on the community. Undoubtedly the demersal fish communities around Ireland have been exposed to high fishing pressure in the last number of decades and this has affected their structures. There are difficulties in using a survey like the Irish groundfish survey as a baseline because the time series started relatively recently, when exploitation was already high. This means the survey cannot provide data to show what the LFI would look like in an unfished or sustainably fished community. In such cases, quantitative target setting can be problematic; however the direction that the indicator should move in is known and can be followed. It is known from the North Sea case that the indicator responds very slowly to a decrease in fishing pressure, and that it can take several decades for significant changes to occur.

Further application of data for marine environmental legislation

The second case study has demonstrated how data on fish species collected on the Irish groundfish surveys can feed into the evaluation of biodiversity and fish community health as required by legislations such as the European **Data collection Framework (DCF)** and the **MSFD**. By using the surveys as a platform of opportunity for further sample collection, it can provide additional data for other descriptors to determine GES as indicated in the diagram below (see Figure 5.9).

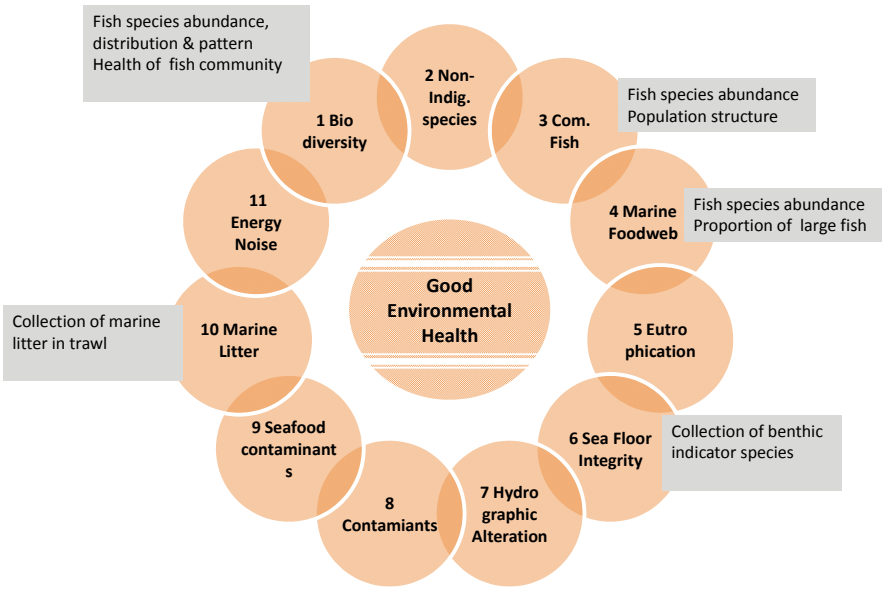


Figure 5.9 **The application of groundfish survey data to the 11 MSFD descriptors.**

Age The number of years of life completed, here indicated by an Arabic numeral, followed by a plus sign if there is any possibility of ambiguity (age 5, age 5+)

Benthic related to habitats and/or organisms on the seabed.

Benthopelagic zone between the seabed and the deeper parts of the water column, benthopelagic fish inhabit this zone.

Biodiversity The variety of plant and animal life in the world or in a particular habitat- a high level of which is usually considered to be important and desirable.

Biomass Measure of the quantity, usually by weight in metric tons (2,205 pounds = 1 metric ton), of a stock at a given time.

Catch The total number (or weight) of fish caught by fishing operations.

Commercial Fish Species Here commercial species are defined as those that have an established commercial value in demersal fisheries e.g. *nephrops*, cod, haddock, whiting, plaice, megrim, black sole.

CFP / Common Fisheries Policy The instrument of fisheries management within the European community **(see http://ec.europa.eu/fisheries/ reform/index_en.htm)**

CPUE /Catch Per Unit of Effort The catch of fish, in numbers or in weight, taken by a defined unit of fishing effort. Also called catch per effort, fishing success, or availability.

DCF / Data Collection Framework Commission Regulation (EC) No. 665/2008 of the 14 July 2008 establishes the Data Collection Framework (DCF), a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy (CFP). Under this regulation the European Commission requires Member States to collect data on Biological and Economic aspects of many European fisheries and related fisheries sectors. **(see: https://datacollection.jrc.ec.europa.eu/)**

Demersal Fish, such as cod, whiting, haddock, sole, plaice, megrim, hake, monkfish normally swim in mid-water at or close to the sea floor.

Discard Are the portion of a catch of fish which is not retained on board during commercial fishing operations and is returned, often dead or dying, to the sea.

Elasmobranchs Fish, such as skates, rays, sharks and dogfish, whose skeletons are cartilagenous rather than boney (as in the teleost species such as cod, whiting, plaice and herring).

Fecundity potential and/or actual reproductive capacity of a fish, measured by the number of eggs it produces.

Fisheries A group of vessel voyages targeting the same species, using similar gear, during the same period of the year and within the same area e.g. the Irish flatfish-directed beam trawl fishery in the Irish Sea.

Fisheries Dependant Data Data from commercial fisheries i.e. landings, effort and market sampling of fish length, weight, age, sex and maturity

Fisheries Independent Data Data collection by scientific surveys using standardized methods which provide consistent information to build up a "time series" of fish abundance

Fishing Effort The fishing effort is a measure of the amount of fishing. Frequently some surrogate is used relating to a given combination of inputs into the fishing activity, such as the number of hours or days spent fishing, numbers of hooks used (in long- line fishing), kilometres of nets used, etc. The European Union defines fishing effort as fleet capacity (tonnage and engine power) x days at sea (time; t); the formulas are GT x t and kW x t.

Groundfish Species of demersal fish such as cod, whiting, haddock, sole, plaice, skates and rays, dwelling on, or close to the sea floor, as targeted in the annual FEAS groundfish surveys around the Irish coast.

ICES International Council for the Exploration of the Seas –Ireland shares the Total Allowable Catches TACs for many stocks we exploit with our European Union partners. Because of this international dimension many stocks need to be assessed in an international fora such as ICES. **(see: http://www.ices.dk/)**

Landings Fish or shellfish that are brought ashore.

LPUE /Catch Per Unit of Effort The landed component of the overall catch, in numbers or in weight, taken by a defined unit of fishing effort.

Marine Institute The Marine Institute is Ireland's national agency with the following general functions : "to undertake, to co-ordinate, to promote and to assist in marine research and development and to provide such services related to marine research and development, that in the opinion of the Institute will promote economic development and create employment and protect the environment." Marine Institute Act, 1991 – **(see: http://www.marine.ie/)**

Maturity The age or stage when a fish can reproduce. Age or size at first maturity is the age or the size when a fish can reproduce for the first time.

Mesopelagic zone in the water column between ca. 200 and 1000m depth. Mesopelagic fish are fish that inhabit this zone.

MFSD Marine Strategy Framework Directive. Its aim is to protect more effectively the marine environment across Europe. It aims to achieve good environmental status of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. (MFSD 2008/56/EC).

Mobile Fishing Gear Fishing gear that is actively towed, also called active or towed gear. This category includes any trawls (e.g. beam trawls, otter trawls, Danish seines, pelagic trawls) and dredges.

Oviparous animals which produce eggs in which the embryo develops and hatches outside the maternal body. Most bony fish and some elasmobranchs are oviparous.

Oviviparous animals which produce eggs, that develop within the maternal body. Some elasmobranch species such as spurdog are oviviparous.

Pelagic Fish that spend most of their life swimming in the water column, as opposed to resting on the bottom, are known as pelagic species (e.g. Mackerel, Horse mackerel, Herring, Sprat and Sardines).

Semi-random depth stratified design Species distribution is influenced by seabed type, depth and latitude among other factors. As a result, it is desirable to divide the survey area into regions (strata) of broadly similar catch type. The strata are allocated according to depth and ICES division (see below) resulting in a depth stratified design. An element of randomness is also required in the allocation of survey hauls so that a complete picture of distribution is estimated and the estimate is statistically robust. Hence within a strata, hauls are randomly allocated.

Sex ratios The ratio between males and females of one species.

Sexual dimorphism difference between males and females of the same species with regards to their shape, size, color or other characteristics.

Survey strata Division of survey areas into regions (strata) of broadly similar catch type to avoid comparing catches across habitats known to be very different. On the IGFS, the strata are defined according to ICES divisions and depth bands, resulting in the 17 strata.

Static Fishing gear Fishing gear that is not actively towed, also called passive gear. This category includes gillnets, longlines, traps and pots.

Stock A "stock" is a population of a species living in a defined geographical area with similar biological parameters (e.g. growth, size at maturity, fecundity etc.) and a shared mortality rate. A thorough understanding of the fisheries biology of any species is needed to define these biological parameters.

TAC / Total Allowable Catch is the total regulated catch from a stock in a given time period, usually a year. To this effect, following analysis of historical catch data, the groundfish survey design divides up the major fisheries management areas (ICES divisions) into depth strata. Starting at the coast, strata limits are 80m, 120m, 200m and finally 600m.

Zooplankton free floating aquatic organisms consisting of small animals such as crustaceans and the immature stages of larger animals such as fish larvae.

Acknowledgements

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